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Full Length Research

Effects of over stocking on the growth rate of *Clarias gariepinus*

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ABSTRACT: The African catfish (*Clarias gariepinus*) were reared at four different stocking densities in a circular plastic bowls to evaluate the effects of over stocking on the growth rate of *Clarias gariepinus*. 140 fish were stocked at 10, 20, 30 and 40 with a mean of 8.5, 8.66, 9.2 and 9.15 respectively. The growth trial lasted for 92 days (June to August). The final mean weight of fish stocked at densities 10, 20, 30 and 40 were 153.1, 121.5, 96.6 and 68.6 (g) fish were with 10% body weight between the hour of 8.00 to 9.00am and 5.00pm to 6.00pm. Feed not consumed are siphoned out to avoid contamination of water which will be toxic to the fish. The corresponding mean values of specific growth rate were 3.05, 2.80, 2.62, and 2.26. The feed conversion ratio (FCR) was 5.91, 5.45, 5.14 and 4.76 and cumulative survival rates were 99.86, 99.65,96 .66 and 92.5%. The temperature ranges from 26.5 to 30.5°C. The pH range from 6.9 to ± 0.36 to 7.25 ± 0.22. The Dissolved oxygen (DO) was 2.65mg/l to 5.41 mg/l. The result revealed that over stocking had a significant effect on the growth rates of *Clarias gariepinus*. Fish held at the highest stocking density of 40 exhibited the lowest growth and survival rate.

Key words: African catfish, over stocking, growth rate.

INTRODUCTION

Aquaculture practices are still in the extensive and semi intensive in Nigeria (Adikwu, 1999) and recently intensive re-circulatory systems (Bolorunduro, 2006). Data on domestic fish production in Nigeria has shown a downward decline over the years, 1982 (920, 484), 1990 (315,000) and 1996 (200, 171) metric tons as reported by (FDF, 1990; FOS, 1997). In order to sustain the current average domestic production of 615,507 metric tons per annum, an effective delivery system has to be put in place (FDF, 2007). Nigeria is amongst the largest consumer of fish in Africa (FAO, 1999); its total available land for aquaculture development according to fisheries statistics of Nigeria is about 1.7 million hectares and existing pond area under cultivation is about 60,000 hactares with a domestic production of merely 0.62 million metric tons while it has an aquaculture potential of producing about 2.5 million tons. Nigeria's current domestic fish production from aquaculture is only about 85, 087 tones and consumption was estimated to be over one million metric tons, in order to reduce importation of fish in Nigeria, there is need to develop local domestic fish production.

Clarias gariepinus is a highly appreciated fish in Nigeria due to its favorable food conversion ratio, resistance to disease, low technology farming system, excellent food meat quality, possibility for high stocking density and can tolerate wide ranges of environmental conditions (Fagbenro et al., 2003) and also they can grow to a large size of over 10kg (Reed et al., 1967; Olaosebikan and Raji, 1999) which are attractive to consumers. Thus, *Clarias gariepinus* was chosen for this study because of its ready availability, economic and ecological advantages.

Environmental stress is an important factor responsible for limiting fish performance under aquaculture conditions. When fish are subjected to adverse environmental conditions, some endocrine and physiological alteration occur, often resulting in changes in ability of the fish to survive, grow and reproduce (Barton and Iwama,

1991) over stocking is a common chronic stressor in aquaculture that can induce a prolonged elevation of Cortisol levls which may cause damaging consequences, and suppressed growth (Rowland et al., 2006). This effect has been attributed to factors such as decreased food consumption. The high stocking density (over stocking) also imposes increased energy demands that require changes of gluconeogenic and glucolytic activities under such conditions, food consumption is reduced. The extra expenditure energy has to be met by the reserve, resulting in reduced growth (Rowland et al., 2006). Over stocking is a common aquaculture practice used to manage water usage or increase fish stocking density (Baras and Lagardere, 1995). However, the use of high stocking density as a technique to maximize water usage and thus increase stock production has also been shown to have adverse effect on growth. In many cultured fish species, growth has indirect relationship to stocking density and this observation is mainly attributed to social interaction (Holm et al., 1990; Haylor 1991; Ma et.al., 2006). Social interactions as a result of competition for food and/or space can negatively affect fish growth. On the other hand, the fish price is influenced by the market requirements such as size and production, which depends on their growth.

According to Brummet, (2000) when the amount of fish stocks exceeds the carrying capacity of the water supply, and the condition of the fish deteriorates then mortality will increase due to rapid growth of protozoa and bacterial diseases and parasites. Therefore by establishing the relationship between dietary protein level and over stocking, stress monitoring of fish stocks and prediction on their growth rate need will be possible and enhanced. With global population expansion, the demand for fish is steadily increasing and natural fish population have declined during the last decade due to environmental degradation and overfishing. This has resulted in an increasing effort in the technology for more domestic production. A lot of people have gone into the fish farming at both subsistence and commercial level in north-central Nigeria; however , there has been low capacity production due to problems of knowing the right size of fish to stock, stocking at too high density (over stocking) and under-stocking of fish (Edward and Demaine, 1988). A lot of farmers have been discouraged by incidence of high mortality in the present day practice in north-central Nigeria .plastic container used in culturing fish is not new in Nigeria , the problem is that the practice has remained at experimental level for over two decades (Okorie,2003). There have been different researches concerning different species of catfish, all over the world for aquaculture because of its high potentiality and preference. Stocking at best density in order to avoid over stocking still attract attention of researchers because factors are aimed at yielding a higher profit for the farmers and getting good quality fish at a reasonably short period of time.

The growth of *Clarias* species depends upon stocking density, dietary, protein quality, energy content of feed, physiological status (age, sex) environmental variables, farming conditions and food availability are some of the main factors that affects fish growth (Lovell, 1989). In terms of the fish production in plastic containers, over stocking (high stocking density) which is related to the volume of water or surface area per fish is an important factor. Increase in stocking density (over stocking) 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 and feel comfortable. Consequently, identifying the optimum stocking density for a species is a critical factor not only for designing an efficient culture system (Leatherland and Cho, 1985), but also for optimum husbandry practices. Controlling the fish size and production are the two importance task to meet the market demands as price of fish is determined by the market demand of supply (Size and production) and that in turn depends on their growth rate. Over stocking (High stocking density) to produce more fish which increase fish intensification may not be the problem of space shortage.

Biology of *Clarias gariepinus*

Clarias gariepinus is a member of the family *clarridae.* They occur naturally in south East Asia and in Africa and are sometimes called Africa catfish or mudfish. *Clarias gariepinus* is well appreciated in many Africa countries (De gram et al., 1996). The *clariids* exhibits many qualities which makes them suitable for culturing. They have a high fecundity, faster growth rate, disease resistance can withstand handling stress as well as been highly palatable (Eroudu et al., 1993; Nwandukwe, 1993). They are very adaptive to extreme environmental conditions and can withstand low oxygen level in the range of 6.5 to 8.0 (Huissman and Ritcher, 1987; Fabgenro and Sydenham, 1988). They are able to live in turbid water and tolerate temperature of 8°-35°c. the optimal temperature for growth is 28°-30°C (Teugel, 1986) *Clarias gariepinus* has long based rayed dorsal fin (reed et al., 1967) without an adipose tissue, two pairs of nasal and maxillary barbles on its dorso ventrally flattened head, elongated body with fairly long dorsal and anal fins and also smallish eyes. This species can attain length of up to 1.7m including the tail and can weigh 59kg when fully grow their color 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* (Teugels, 1982). The Africa catfish are omnivores (Reed et al., 1967) feeding on a large variety of plant and animals like weed, planktons, small insects, small fish, crustaceans, worms etc. (Bakare, 1968) but they have high tendency towards been a carnivores as adult. Catfish are therefore said to be an opportunistic feeder, feeding on virtually everything that come their way.

Stocking density and culture

Over stocking (high stocking density) is one of the main factors determining the growth rate of fish (Engle and Valderama, 2001; Rahman et al., 2005) and the final biomass harvesters (Boujard et al., 2002). Environmental variables, farming conditions and food availability are other factors that can affect fish growth. in terms of the fish production in plastic container, over stocking (stocking density) which is related to the volume of water or surface area per fish is an important factor. Increase in stocking density that is over stocking result in increasing stress, which leads to higher energy requirements causing a reduction in the growth rate and food utilization (Aksungur et al., 2007).

Contrarily, in case of low stocking densities fish may not form shoals or 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 (Leatherland and Cho, 1985) but also for optimum husbandry practices. Controlling the fish size and production are two important tasks to meet the market demands. increase in stocking density (over stocking) to produce more fish which increase fish intensification may not be the best way of dealing with problem of space shortage (Aksungur et al., 2007). In many cultured fish species, growth is inversely related to stocking density and this is mainly attributed to social interactions and fool (Huang and Chiu, 1997; Haylor, 1991; Bjorensson, 1994; Irwin et al., 1999; Ma et al., 2006). Social interaction through competition for food or space can negatively affects fish growth while the price of fish is determined by market demand of supply (size and production) which in turn depends on their growth.

Paspt et al. (1992) suggested that in intensive aquaculture the stocking density is an important indicator that determines the economic viability of the production system. In intensive larvae and fry culture, several factors influence survival welfare, growth and production for example feeding (Kerdchwen, 1992; El-sayed, 2002), stocking density (Rahman et al., 2005; Schram et al., 2004).

The effects of over stocking on the growth rate and survival have been studied on some African catfishes such as *Clarias gariepinus* (Haylor, 1992) and *Heterbrancus longifilis* (Ewa-oboho and Enyenihi, 1999; Coulibaly et al., 2007). The effects of over stocking on tilapia production as reported by Otubusin and Opeloye, (1985) in floating bamboo-net cages in Kigera III reservoir New Bussa, Nigeria shows that fish growth generally decreased with an increase in stocking density. The slow growth rate of the fish observed in the study may be attributed to low productivity of the Kigera III reservoir.

Muthukumarana et al. (1985) carried out an experiment using *sarotherodon niloticus* in cages (at three stocking densities; 400, 600 and 800m^3) fed varying crude protein levels for a period of four months; it was observed from his result that there was no weight gains and feed conversion ratio between stocking densities for a particular dietary crude protein level. (Osotero *et al*., 2007) revealed that over stocking has an inverse relationship with level of protein intake which affects weight and growth of fish (*Clarias gariepinus*). Growth is the manifestation of the net outcome of energy gains and losses within a framework of abiotic and biotic conditions. 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 (Bjoernsson, 1994) space is a factor which can be used to determine the fish growth rate in aquaculture (Otubusi, 2000).

Nutritional requirement

Protein requirement

Dietary protein requirement of Africa catfish have been reported by several authors; Fagbenro et al. (1992) reported 42.5% dietary protein requirement for *H. longfilis*. In *Clarias gariepinus*, the protein requirement of fingerling, juveniles and adult fish varies. For instance, juveniles and fingerlings require more protein compared to the adult (Halver, 1978) reported that the gross protein requirements are highest in initial feeding and that it decrease as fish increase in size. Machiels and Haenke, (1986), Ayinla, (1988) and Degani et al. (1989) concluded that *Clarias gariepinus* brood stock requires about 40% crude protein for *Clarias anguiclarias* and (Fagbenro et al., 1992) recommended 40-42.5% for *Heterancus bidorsalis*. The quality of protein in any feed stuff is principal influenced by its amino acid composition (Ayinla, 1991) and this is turn induces its digestibility in the diet. Digestibility of some amino acids varies amongst ingredients. Fish utilizes both plant and animal proteins although the latter is more nutritionally better. The more closely the dietary protein meets. The qualitative requirement of indispensable amino acid by the fish, the greater its utilization, for cultured fish try to grow at a maximum rate, it must have a diet in which have its digestible feed ingredient consist of balanced protein (indispensable amino acid). Ayinla (1991), stated that deficiency in any of these ten essential amino acids will cause reduced appetite, reduced growth rate, disease or even death in fish. The ten indispensable amino acid needed for growth are *Arginine, Histidine, Isoleuline, Leucine, Lysine, Methionine, Phenylalanne, Valine, Threonine and tryptophan* (NRC, 1993). Fagbenro et al. (2000) reported that the estimated essential amino acid requirements in (g/kg protein) for *Clarias gariepinus* as *argentine* (445), *Histindine* (21.5), *Isoleucine* (30.6) *Leucine* (52.2), *Lysine* (57.6), *Methoinone* (18.3), *Phenylalamone* (27.3), *Threonine* (31.6) and *Valine* (29.0).

Carbohydrate requirement

The carbohydrate-based feed stuffs are usually the cheapest source of energy for cultured fish due to their relative abundance. Buhler and Halver, (1961) reported that relatively high levels of carbohydrates are tolerable by carnivores' fish and that dietary carbohydrate levels of around 20% may be optimal. Fiber has no nutritional value in feed (Sado, 1989) apart from aiding the passage of food into the gut of fish. A dietary excess or deficiency of useful energy can reduce growth rate because energy needs for maintenance and voluntary activity must be satisfied before energy is available for growth. Energy is a nutritional requirement for the culture of animals. Failure to include adequate quantity in diet may result in reduced growth while excessive quantities of energy results in undesirable fat deposition or reduced feed consumption (NRC, 1993).

Fats requirements

Lipids include free fatty acids, triglycerides, phospholipids, oils, waxes and sterol. All these lipids provide dietary energy which is about twice as much as the energy produced by carbohydrates and protein Sado (1989) and Catacutan (1999) revealed that homoeothermic animals have dietary lipids are an important source of energy and the only source of essential fatty acids (EFA) in fish, only differs in species and from age and size (Shepherd and Bromage, 1992) determining requirements for fatty acid is difficult for fish because the metabolic requirement is very small and fatty acids stored in the body or even carried over from egg yolk can influence performance of the experimental fish according to Lovell, (1987).

Vitamins and minerals

Vitamins are organic compounds required by fish in very small amounts for growth, metabolism of tissue nutrients and diseases resistant. Vitamin are either fat or water soluble; water soluble are easy leached from polluted feeds when they come in contact with water and they include *thiamine, riboflavin, pyridoxine, Pantothenic acid, Nicotinic acid, Biotin Inisitol, Choline, Folic acid, B-12 and Ascorbic acid* (Ayinla, 1991). In highly stocked plastic containers, it is important to feed with complete diets since it is doubtful if the nutrient supply of natural food organisms in water body will be adequate to meet the vitamin requirements of the fish. Mineral requirements of fish is similar to those of terrestrial animals. fish requires minerals in trace amount for tissue formation and other metabolic activities.most important minerals are calcium (Ca) and phosphorus (P) which must be supplied in sufficient quantities (Lall, 1991) although fish absorbs some of these minerals in water and reduce their requirement, nevertheless, it is safer to supply adequate amount of calcium in feeds to forestall possible deficiency symptom in fish. Comparably, P is lower than Ca in natural water so it does not occur in reasonable amounts. The most reliable source of phosphorous (P) for fish is through its diet Sado, (1989) reported that blood meal, bone meal and limestone inclusion into feeds can effectively take care of the deficiency.

Water quality parameters

Fish and other aquatic organisms such as shrimps and crayfish are known to be very rich in protein and need to cultivate these in clean water in the locality is highly needed. The need for clean water to raise this protein rich and needed aquatic commodity cannot be over emphasized. The productivity of a given body of water is determined by its physical, chemical and biological properties. These environmental properties of water need to be conducive for fish to grow well; therefore, an ideal water conditions is a necessity for the growth and survival of fish. The population density of organism of any water system such as in land fresh water and lakes always vary according to the physico-chemical factors such as hydrogen-ion concentration (PH), dissolved oxygen (DO) conductivity, nutrient and temperature (Abolude, 2007).

Temperature

Water temperature is one of the major environmental factors that affects and controls food utilization at all levels and stages of fish growth. The suggested temperature ranges from 20 to 30°C while the lethal levels are from 2 to 42°C. Fish are poikilothermic and water plays an important role in their feeding as it affects their metabolic activities, feeding potential, growth, survival, reproduction in all species of fishes (Dupree and Hunner, 1994). Temperature has a pronounced effect on the rate of chemical and biological processes in water; for instance, fish require twice as much oxygen at 30°C than 20°C (Adeniji and Ovie, 1990). It is recommended that fish in the tropics be kept in water whose temperature range is between 25 - 30°C (Auta, 1993). Sudden increase in temperature will stress or even kill fish and this has formed the basis for the acclimatization of fish (Adeniji and Ovie, 1990). Temperature has been found to affect the dominance and distribution of phytoplankton in water as it influences the growth rates and mortality of planktons and other organism (Orchutt and Porter, 1983). Temperature is known to influence organisms to varying degrees, depending on their sensitive thus fish survival in plastic container depends on temperature and dissolved oxygen (Countotant, 1987).

Dissolved oxygen

Dissolved oxygen in water is very essential to life in the aquatic environments as it affects the physiology and distribution of the aquatic organism. Nearly all aquatic organisms with the exception of some bacteria must have oxygen to survive and most of these organism mushes extract their oxygen from liquid water. The two main sources of oxygen into the aquatic environment are the atmosphere and photosynthetic activities of aquatic planks. The ideal range of dissolved oxygen in the water must be at least 5mg/l is required to sustain fish and other aquatic life in water bodies (Adakole, 2000). Insufficient dissolved oxygen (D.O) in a water system tend to cause anaerobic decomposition of organic materials in water thereby leading to the production of obnoxious (annoying) gases such as carbon dioxide, hydrogen sulphides and methane which bubble to the surface. The physiology of aquatic organism is such that they can tolerate only narrow ranges of temperatures, outside which they cannot function normally (Willoughby, 1976). Kutty, (1968) and Kutty and Sunders, (1973) reported that Atlantic salmon stopped swimming when dissolved oxygen concentration remained below 5ppm but goldfish, tilapia and carps swims at oxygen level of 1 to 2 ppm. Inadequate dissolved oxygen has many effects of fish like reduced feeding; impaired growth and leading to fish becoming stressed thereby becoming susceptible to diseases. Cold water fish require large amounts of dissolved oxygen with temperature range of 5 to 15°C while warm water fish with a temperature range of 20 to 40°C are able to survive with low oxygen content.

Hydrogen-ion concentration

The hydrogen ion concentration (pH) of any water is the measurement of acidity or alkalinity of that water body. It is usually measured on a scale of 0-14 with 7 being neutral. The effect of pH on the chemical, biological and physical properties of a water system makes its study very crucial to the lives of the organisms in the medium. Fresh waters with a pH ranging from 6.5 to 9.0 have been known to be productive and recommended as suitable for fish culture (Adeniji 1986; Auta, 1993). Increase in acidity and alkanity of any water body may increase or decrease the toxicity of poison in the water; solar radiation and temperature accelerates photosynthesis, which in turn increase carbon dioxide absorption altering the bicarbonate equilibrium and producing OH- thus raising the pH (Branco and Senna, 1996).

Hynes, (1974) observed that PH values below 5 or above 9 are harmful to most animals within the normal range, according to Wuhramann and worker (1982) and Krenkel (1974) pH has more influence on some poison. Chronic pH levels may reduce fish reproduction and are associated with fish die-offs (Stone and Thomforde, 2006) (Adeniji and Ovie, 1990) reported that acid and alkaline death point is approximately at pH 4 and 11 respectively.

In view of the above, the aim of the research is to determine the effect of overstocking on the growth rate of *Clarias gariepinus*

MATERIALS AND METHODS

Experimental fish

One hundred and forty fingerlings of *clarias gariepinus* were obtained from a reputable farm: Efugo's Farm in Kuje – Abuja, Nigeria. The fish were transported to the Department of Biological Sciences University of Abuja in 50 litres plastic which was half filled with fresh water at the early hour in the morning to avoid mortality due to high temperature, and were acclimatized for one week .The mean initial weight for the fish was 8.9±0.4 g and the length was 0 to 10 cm. During the period of acclimatization the fish were feed with coppens at 20% body weight (10% in the morning 8:00 to 9:00 am and 10% in the evening 5:00 to 6:00 pm.

Feeding and measurement

At the end of the acclimatization period the fish were randomly selected and stocked into four (4) circular plastic bowls at different stocking densities of 10, 20, 30 and 40 for treatment 1, 2, 3 and 4 respectively. The bowl with the lowest stocking densities (10) served as the control. The positioning of the bowls allowed a natural photoperiod of 12 h sunlight and 12 h darkness throughout the experiment and the other forty are stocked for replicates. The fish were feed with coppens (an artificial pellated floating feed containing 42% crude protein) with 10% body weight (5% in the morning and 5% in the evening between the hours of 8:00 to 9:0am

Plate 1: Images showing how fishes are been stocked in different circular plastic bowls.

and 5:00 to 6:00pm respectively. The feed for each treatment and its replicate were weighed in separate nylon for onward feeding. The feed particle size increased periodically as the fish grow. The fish were weighed using a weighing scale at the commencement of the experiment and on a weekly basis during the experiment and a calibrated measuring ruler (cm) was used to take the length of the fish at the commencement of the experiment and weekly basis for 12 weeks.

Circular bowls and water management

The circular bowls of the same size with 80 litres capacity per each were bought from Gwagwalada market. The bowls were washed and filled with tap water to 40 liters capacity (the fish were given equal room). The bowls were covered with mosquito nets to prevent the fingerlings jumping out and also intrusion of insect and other foreign bodies (birds). The water in the bowls was changed after three days interval to avoid accumulation of toxic waste which will be harmful to the fish (Plate 1).

Growth response

To determine the growth response of the fish the following parameters were calculated:

Mean weight gain (g)

$MWG=Wt_2-Wt_1$

Where, Wt_1 = initial mean weight of the fish at time T_1 and Wt_2 = final mean weight of fish at time T_2

Specific growth rate (SGR)

$SGR=100 (Log_eWf - log_eWi)/time$ (days)

Wf =final average weight at the end of the experiment, Wi = initial average weigh at the beginning of the experiment, Log_e = natural logarithm reading and Time = number of days for the experiment.

Survival rate (%)

Survival rate (%) = number of fish that survived X 100/ total number of the stocked

Feed conversion ratio (g)

FCR=weight of feed given/fish weight gain.

Mean length gain (cm)

$MLG=Lt_2-Lt_1$

Physiochemical parameter

Temperature

Surface water temperature was read twice daily to the nearest °C with the aid of mercury in glass thermometer and data observed were recorded.

pH

The pH of the water body was also carried out twice daily with the use of water test quality apparatus containing micro-pipette, a test-tube and an indicator. Water was taken from the fish pond (treatments) with the use of micro-pipette, and then released into a calibrated test-tube, at the level of 10 ml, and then four drops of indicator was added, to observe the acidity and alkalinity of the water.

Dissolve oxygen

The alkaline Azide modification of winkers method was adopted for determination of DO in water. 100 ml of the fish water sample was transferred into a 250 ml conical flask and 2 ml of manganese sulphate solution was added, followed by 2 ml of sodium iodide azide reagent, with a dropping pipette below the surface of the water. The conical flask was stopped to exclude air bubbles and the solution mixed thoroughly by inverting several times, until a clear solution is obtained. More also, 2 ml of concentrated sulphuric acid was added by allowing the acid run down the neck of the flask and the flask re-stopped and the solution mixed by gentle inversion until dissolution is complete. The solution was titrated with 0.0125 m sodium thiosulphate ($Na_2S_2O_3.5H_2O$) solution to a pale straw colour. 1 ml of starch solution was added and the titration was continued by adding the thiosulphate solution drop-wise until the disappearance of the blue colour.

Calculation:

$$\frac{\mathrm{Mg}}{\mathrm{L}}\mathrm{Do} = \frac{16000 \text{ x M X V}}{\mathrm{V2/V1(V1-2)}}$$

Where; M = molarity of thiosulphate solution, V = volume of the thiosulphate used for titration, V1 = volume of the bottle (250ml) with stopped in place and V2 = volume of aliquot taken for titration.

Data analysis

Data were analyzed by analysis of variance (ANOVA) (Snedecor and Cochran, 1982) and the differences between means were examined using least significant difference test.

RESULTS

Mean weight gain

The initial weight in all the treatment was 8.9±0.4 (9): range was between 8.5 to 9.15 g while the mean final weight in all the treatment was 109.9±35.9 g the range was from 68.6 to 153.1 g. The daily weight gain shows an inverse relationship; as stocking density increase, the control pond (10) had the highest final mean weight of 153.1 g followed pond A (20) with 121.5 g and B (30) with 96.6 g while the least was recorded in pond C (40) having mean final weight of 68.6 g. This result shows that there was significant difference ($P<0.05$) between the mean final weight gain in all the treatments which shows that as the stocking density increases the weight gain decreases.

Feed conversion ratio

The analysis of the feed conversion ratio, which expresses the efficiency of fish in converting food to flesh was best in the control pond (10) having FCR of 4.76 followed by pond A with 5.14, pond B 5.45, and the least was in pond C with 5.91. There was a significant difference ($P< 0.05$) in the FCR in all the treatments.

Specific growth rate

The specific growth rate in this study shows that as the stocking density increases growth rate decreases (Figure 1). The control pond had the best SGR of 3.05, pond A 2. 80, pond B 2.62 and the least was in pond C having 2.26. One can also conclude that there was no significant difference ($P<0.05$) in the SGR between ponds A, B and C.

Survival rate

The mean survival rate ranged between 92.5 to 99.86%. Control pond, pond A and pond B had the highest survival rate while the least was in pond C.

Physiochemical parameters

The water temperature in all treatments (ponds) ranged between 26.51±1.54 to 27.4±1.39°C. The temperature of

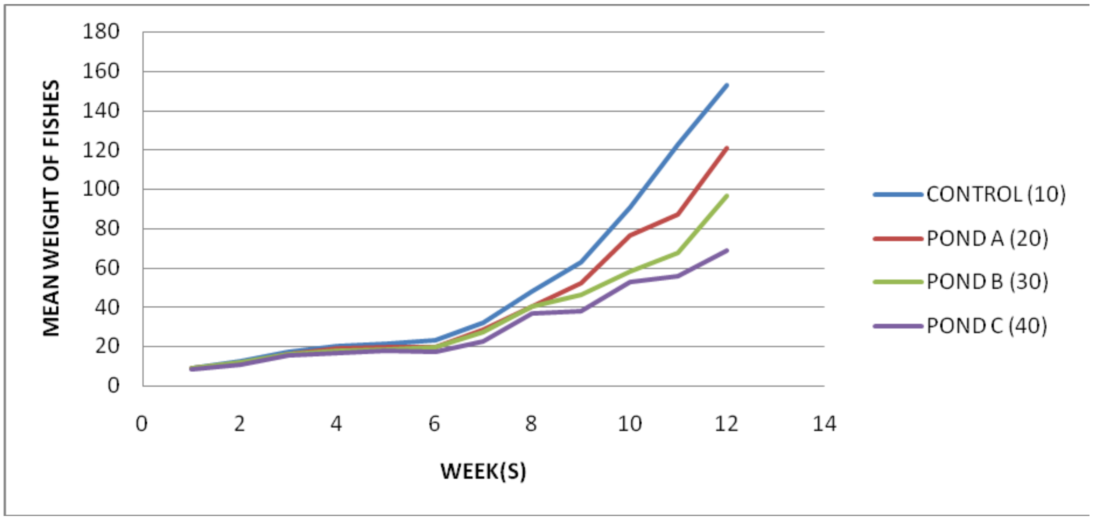

Figure 1. Mean weight fish stocked at different stocking densities.

Table 1. Physiochemical parameters of water in all the ponds.

Parameters	Control	Pond A	Pond B	Pond C
Temperature	26.51±1.54	26.33±1.61	27.01±1.23	27.4±1.39
pH	6.92±0.36	7.05±0.39	7.25±0.22	7.00±0.40
Dissolved Oxygen	5.41±2.18	4.79±1.85	3.25±0.61	2.65±1.97

the water in pond B and C was highest due to over stocking (Table 1).

Hydrogen ion concentration

The hydrogen ion concentration ranged from 6.92±0.36 to 7.25±0.22 and the pH 7.25 was highest in pond B.

Dissolved oxygen

The dissolved oxygen (DO) during the culture period was highest in the control pond 5.41±2.18 (Table 1).

DISCUSSIONS

The survival of *clarias gariepinus* ranged between 92.5 to 99.8% which is compared to a similar work done by Otubusin, (2000) and Osofero et al. (2007) with a range of 98.5 to 99.5%. The high survival rate recorded in all the treatments could be attributed partially to the physiochemical parameters and the good health condition of the fish. This result also indicates an inverse relationship between survival rate and stocking density. It was observed that as stocking density increases survival decreases (Figure 1). This is due to stress experienced as a result of aggressive feeding behavior where energy meant for growth is used up in frenzy feeding activities.

The growth and mortality of *Clarias gariepinus* cultured at various stocking density were not initially affected by density but the overall harvest in terms of final weight and size were directly related to stocking density (Table 2 and Figure 2). As the stocking density increases the weight gain decreases. This depicts an inverse relationship as was observed in similar works by Otubusin (2000). Growth is a manifestation of the net outcome of energy gains or losses within an environment. Weight gain is one of the important indices for measuring growth which was obvious among different ponds (treatments).

The water temperature range in this study falls within the idea temperature required for catfish culture in fresh water. The temperature range of 26.2 to 27.8 also agrees with work of Adeogun et al. (2004) on the culture of *Clarias gariepinus* in pond water.

The water pH range of 6.9 to 7.25 in this study falls within tolerable range of which catfish cultivation which agrred with the pH ranges observed by Thomas and Michael (1999) and Khattab et al. (2000).

The dissolved oxygen of 5.4 recorded in this study also agrees with similar work reported by Otubusin and Olaitan (2001).

The feed conversion ratio in this study showed that the

Table 2. Growth performance of *Clarias gariepinus* in a circular plastic bowl at different stocking densities.

Pond	(SD)	IWT(g)	FWT(g)	MWG	SGR	FCR	SUR%	MLG	DWG	DLG	ILT	FLT
Control	10	8.5	153.1	144.6	3.05	4.76	99.86	16.62	1.56	0.18	8.71	25.33
A	20	8.66	121.13	112.98	2.80	5.14	99.65	14.43	1.21	0.15	8.76	23.19
B	30	9.2	96.6	87.4	2.62	5.45	96.66	13.16	0.95	0.14	8.85	22.01
C	40	9.15	68.6	59.45	2.66	5.91	92.5	12.99	0.65	0.14	8.03	21.02

SD, stocking density, **SGR,** specific growth rate, **IWT,** initial weight, **FCR,** feed conversion ratio, **FWT,** final weight, **SUR,** survival rate, **MWG,** mean weight gain, **MLG,** mean length gain, **DWG,** daily weight gain, **DLG,** daily length gain, **ILT,** initial length, **FLT,** final length.

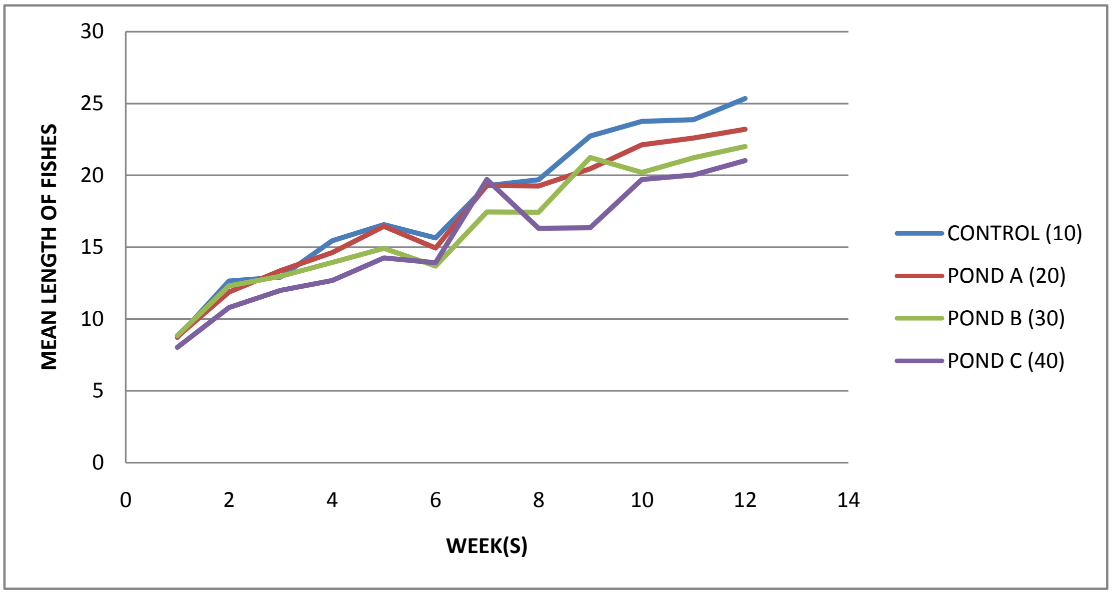

Figure 2. Mean length fish stocked at different stocking densities.

control pond had the best conversion ratio of 4.76 while pond C had the lowest of 5.91. The ability of *Clarias gariepinus* to utilize feed nutrient at maximum biochemical efficiency allows for higher feed conversion ratio. This study shows that at higher stocking density (over stocking) fish expend more energy due to aggressive feeding than converting it to flesh. The overall weight gain at stocking density of 40 fishes in a circular plastic bowl was low and may be attributed to high energy being expended during feeding (aggressive feeding) whereas at lower stocking density of 10 fish higher conversion to flesh and weight was obvious. The value of feed conversion in this research shows that stocking density has an effect on the ability of fish to convert it feed into flesh and may also be attributed to feeding techniques, quality of feed and temperature variation.

Specific growth rate decrease with increase in stocking density. The growth rate of 3.05 g observed in this study was lower than 4.2 g reported for *Clarias gariepinus* by Otubusin (2000).

Growth according to Bowen (1982) was 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.

Conclusion and recommendation

Over stocking is one of the major problems that affect the growth rate of fish. Increase in stocking density result in an increasing stress, which leads to higher energy requirement and also causes a reduction in growth rate and food utilization. Consequently, identifying the optimum stocking density for specie is a critical factor not only for designing an efficient culture system but also for optimum husbandry practices. Controlling the fish size and production are two important tasks to meet the market demands. However, the stocking density of 10 to 20 fishes in a circular plastic bowl of 80 litres with a water volume of 40 litre performed better than 30 to 40 fingerlings. That is, over stocking has a significant effect on the growth rate of *Clarias gariepinus*. Therefore, it is recommended that for optimum productivity, density of fish stocked in a circular plastic bowl of 80 litres should not exceed 25 fish. However, further research can be carried out using different species of fish and different container to determine the effect of over stocking on the growth rate of *Clarias gariepinus*.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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