Growth Performance and Nutrients Utilization of Clarias gariepinus Burchell, 1822 Fingerlings at Different Stocking Density in Concrete Tanks

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Abstracts

One thousand, five hundred fingerlings of C. gariepinus of average weight 2.14±0.01g and standard length of 2.03±0.01cm were randomly stocked into 12 concrete nursery tanks at 50, 100, 150 and 200fish/m^3 tank and fed with commercial feed (Coppens) of different sizes (49% and 42% crude protein). The fingerlings were fed at 5% body weight twice daily for a period of 10 weeks. Growth performance and nutrient utilization parameters such as mean weight gain (MWG), feed conversion ratio (FCR), protein intake (PI), specific growth rate (SGR) and survival rate (SR) were determined. Data obtained were subjected to descriptive analysis, analysis of variance and correlation analysis at α 0.05, to determine the significant difference in the means of experimental parameters. Fish stocked at 50 fingerlings per tank performed better with highest mean weight gain (17.30g), highest specific growth rate (1.88%), relative growth rate (909.09) and survival rate (90.0%). Highest protein efficiency ratio (1.54) was recorded in fish stocked at 50 fingerlings per tank. Highest feed conversion ratio (1.50) was recorded at 200 fingerlings per tank. The results show that stocking density inversely affects the growth and survival of C. gariepinus fingerlings. Optimum stocking density was recommended for optimal growth and survival and efficient nutrients utilization.

Introduction

Fish provides a rich source of protein for human consumption and constitutes about forty percent (40%) of the total animal protein intake by the average Nigerian; hence, there is great demand for fish in the country. According to Ugwumba and Ugwumba (2003), the demand for fish in the country has been on the rise with demand far exceeding supply. Fish supply in Nigeria is about 600,000 metric tons while demand is put at 2.6million metric tons, this makes Nigeria one of the largest importers of frozen fish in the world as she imports about 2 million metric tons annually to meet the demand for fish (Federal Ministry of Agriculture and Natural Resources, 2008). This massive importation of frozen fish in the country has ranked Nigeria the largest importer of frozen fish in Africa. It has been noted that Nigeria can be fully self-sufficient in fish production, while local capacity can potentially turn the country from being a net importer of fish and fish products to a net exporter. The awareness of the need for adequate protein in human diet has greatly increased in many developing regions of the world, and fish has been widely acknowledged as a rich source of dietary protein (Ajayi, 2001). Akinyemi (1998) projected that fish demand would increase from 1.392 million tons in 2001 to about 1.688 million tons in 2010. Aquaculture therefore remains the only viable alternative for increasing fish production in order to meet the protein demand of the people (Omitoyin, 2007). Aquaculture has the same objective as agriculture, such as, to increase the production of food above the level that would be produced naturally.

Also, one of the priorities of aquaculture is the increase in the production and the growth rate of fish that will meet the demand of the increasing population. C. gariepinus is generally considered to be one of the most important tropical fresh water fish species for aquaculture whose aquaculture potential have been documented (Dada and Wonah, 2003). Tyor and Pahwa (2017), pointed out that C. gariepinus has high fecundity rate, grows faster, tolerate high stoking density and environmental extremes, it also accepts wide range of natural and artificial food and adapts to a variety of feeding modes in expanded niches. A review 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). One of the ways to increase the production, growth and survival rates of C. gariepinus fingerlings is through a reliable stocking density so that consumers and farmers can actualized their desired objectives which is usually growth for economical and profit maximization. One of the major hindrances to the development of aquaculture industry in Nigeria is the lack of reliable information on the optimum stocking density for C. gariepinus fingerlings, intended to be raised to juveniles in concrete tanks. Although potentials abound in Nigeria for the production of C. gariepinus fingerlings in concrete tanks, desired objectives of increased growth performance and survival rate of raising them to juveniles will only be actualized, through a reliable stocking density. According to Viveen et al. (1985); optimum stocking density for effective tank management of fingerlings must be established since growth performance and survival rate in confinement are largely influenced by stocking density. Therefore, the importance of increased growth performance and survival rate of C. gariepinus fingerlings to juveniles cannot be overemphasized, for aquaculture to thrive and help bridge the already existing wide gap between fish demand and supply especially in Nigeria. It is to this that growth and survival rates of C. gariepinus fingerlings raised to juveniles, at different stocking densities in concrete tanks will be evaluated in this research.

Materials and Methods

Study Site
The study was carried out in the experimental tanks of fish farm, Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan

Experimental Design
The experimental set-up consisted of twelve concrete tanks of size 1m x 1m x 1m situated in the indoor facilities of fish farm of the Department of Aquaculture and Fisheries Management University of Ibadan. Prior to the commencement of the experiment, the concrete tanks were properly cleaned and treated with $CaCO_3$, which is adjudged to be a good disinfectant (Bolorunduro,1999) with an application of $100m^{-3}$ as recommended (Ibiwoye, 1996) before stocking the fish. C. gariepinus fingerlings (2.14±0.01g) were randomly stocked into concrete tanks (1m x 1m x 1m) and filled with water up to three-quarter of the depth of each tank (about 0.75m). Water was drained from the tank weekly, while its level was maintained daily by "flow-through" method at on liter per minute (1L/min). The experimental design consisted of four triplicate treatments in a completely randomized design. The treatments in triplicates consisted of 50, 100, 150 and 200 fingerlings for treatments T1, T 2, T3 and T4 respectively.

Experimental Fish
The fingerlings were procured from Durante Fish Industries Limited in Ibadan and transported in a well oxygenated bag to fish farm of the Department of Aquaculture and Fisheries Management .A total of one thousand five hundred C. gariepinus fingerlings of average weight of 2.14±0.01g and average length of 2.03±0.01m were stocked in experimental tanks at 50, 100,150 and 200 fingerlings/m^3. Triplicate tanks were considered for each stocking density. Fish were measured and weighed weekly from each tank. Fish were weighed using electronic compact sensitive scale (KERRO BL10001) of 0.1g to 1000g taken in centimeters using meter rule, for 10 weeks.

Experimental Diet
The experimental diet used throughout was a commercially prepared floating pelleted feed (Coppens), bought from Commercial Fish Feed Seller (Adom Feed Mill, Orogun, Ibadan) in Ibadan. The sizes of the commercial feed fed the fish were 1.5mm, 2mm and 3mm. The proximate compositions of different sizes of the experimental feed are presented in Table 1. All the experimental fish were fed twice daily, between the hours of 08:00 – 09:00am and 04:00 – 05:00pm for 70 days. The fish were fed with 1.5mm commercial feed (Coppens) for the first three (3) weeks, at 3% of body weight. Between the fourth (4^{th}) and the seventh (7^{th}) week, 2mm commercial feed was fed to the fish at 5% of body weight twice daily. Commercial feed of 3mm size was fed to the fish at 5% body weight from the eighth week. Equal rations were offered twice a day at 09:00 hr and 17:00 hr. Feeding allowance was adjusted in accordance to increase in body weight (Hogendoorn and Koops, 1983). Feed input was adjusted fortnightly based on the increase in body weight after the weight determination.

Water Quality Parameters
Water samples were collected from the experimental tanks with 100cl dark bottles to the Laboratory for analysis. Water parameters measured included dissolved oxygen, pH and temperature.

Dissolved Oxygen
This was done by Winkler's method as outlined by APHA, et. al., (1999). This involves titration method of fixing the dissolved oxygen in a known volume of water with manganese-sulphate and alkaline iodine-oxide solution. A brownish colouration precipitate appeared which indicates the presence of oxygen in water. Then, H_2SO_4 was added to release the iodine. The released iodine was then estimated by titration with standard 0.025m sodium thiosulphate solution, to give the value of oxygen in the tank water

Determination of PH
Water samples were collected from the experimental tanks to the Laboratory to analyze. The pH of the water samples was determined by the use of digital pH-meter. The pH-meter was dipped into the water samples and after stabilizing, the readings were then recorded.

Temperature (°C)
This was done by the use of mercury in glass-thermometer. The mercury in glass-thermometer was placed at about 10 to 15cm below water for two minutes and quickly removed. The readings were then taken.

Growth Response of the Fish
Trends in growth response of fingerlings over the experimental period for the four treatments were graphically illustrated.The growth responses of the fish are the indices used to evaluate the response of the fish to the feeding levels based on the stocking density. The following parameters were calculated as shown in equations 1-9.

Initial mean weight and final mean weight (g)

Mean weight gain (MWG)

$MWG = Total\ weihgt\ gain\ (g)/No\ of\ fish$ .... (1)

Percentage weight gain (PWG)

$PWG = Mean\ weightgain(g)/Initial\ mean\ weight(g)X100$ .... (2)

Relative growth rate (RGR)

$RGR = Final\ mean\ weight\ (g)/Initial\ mean\ weight(g)x100$ .... (3)

Specific growth rate (SGR)

$SGR = loge\ final\ mean\ weight(g)_{Loge} initial\ mean\ weight(g)/Number\ of\ daysx10$ .... (4)

Survival rate (SR)

$SR = Number\ of\ fish\ that\ survived/Total\ number\ of\ fish\ stocked\ x100$ .... (5)

Protein intake (PI)

$PI = \%\ protein\ in\ feedxTotal\ diet\ consumed/100$ .... (6)

Protein efficiency ratio (PER)

$PER = Mean\ weight\ gain(g)/^{Protein\ intake}$ .... (7)

Total weight gain (TWG)

$TWG = Final\ weight - Initial\ weight$ .... (8)

Feed conversion ratio (FCR)

$FCR = Total\ weight\ of\ feed\ given(g)/Total\ fish\ weight\ gain(g)$ .... (9)

Data Analysis

Experimental data were subjected to descriptive analysis, analysis of variance and correlation analysis at p< 0.05 to determine the level of significance difference in the means of experimental parameters.

Results

Water Quality Parameters

Water quality monitored throughout the study period showed dissolved oxygen level range between 4.8 and 4.9. The highest pH level recorded during the experimental period was 7.1 and the lowest was 6.9. The lowest temperature recorded was 25°Cand the highest was 26°C (Table 1). The values obtained in this study in agreement with the recommended ranges as opined by Omitoyin (2007) for C. gariepinus.

Growth Performance

There was decreased growth performance in mean body weight gain with increase in stocking density (Fig 1). This trend is in contrary to the observation of Dasuki, et al., 2017 which observed increased body weight with increasing stocking density in C. gariepinus raised in bamboo cage which might be responsible for the difference. However, the trend in this study is similar to that of Umanah and Dapa, (2017) on albino C. gariepinus raised in collapsible tarpaulin cage.

Table 2 shows the summary of the result obtained for growth responses of C. gariepinus fingerlings raised in concrete tank. There were trends of decreasing growth performance on the basis of mean body weight gain with increased stocking density. The highest mean weight gain of 17.29g/fish was recorded in treatment T1 (50 fingerlings/m^3) while the least mean weight gain of 14.59g/fish was recorded in treatment T4(200 fingerlings/m^3).There was a significant difference ($p<0.05$) between mean body weight gain of fish in all treatments. The highest and the lowest specific growth rate 1.88%/day and 1.72%/day were recorded in treatment T1 (50 fingerlings/m^3) and treatment T4 (200 fingerlings/m^3), respectively.

There was a significant difference ($p<0.05$) between specific growth rate (SGR) of fish in all treatment. Bomboe et al. (2002) observed that fish reared at lower densities had significantly higher SGR than fish reared at higher density. Highest relative growth rate,(RGR) 909.09% was recorded in treatment T1(50 fingerlings/m3) while the lowest relative growth rate(RGR) of 777.42 was recorded in treatment T4 (200 fingerlings/m^3).There was a significant difference ($p<0.05$) between growth rate of fish in all treatment. Highest survival rate (SR) of 88% was recorded in treatment T1 (50 fingerlings/m^3) while the lowest of 79% survival was recorded in treatment T4 (200 fingerlings/m^3). There was significant difference ($p<0.05$) between survival of the fish in treatment. Feed conversion ratio increased with increasing stocking density. The highest value of protein intake of 11.3 was recorded in treatment T1 (50 fingerlings/m^3) while the lowest value of 9.7 was recorded in treatment T4 (200 fingerlings/m^3) Protein efficiency ratio had values ranging from 1.53 in treatment T1 (50 fingerlings/m^3) to 1.50 in treatment T4 (200 fingerlings/m^3).

Table 1: Proximate Compositions of Experimental Diet of Different Sizes

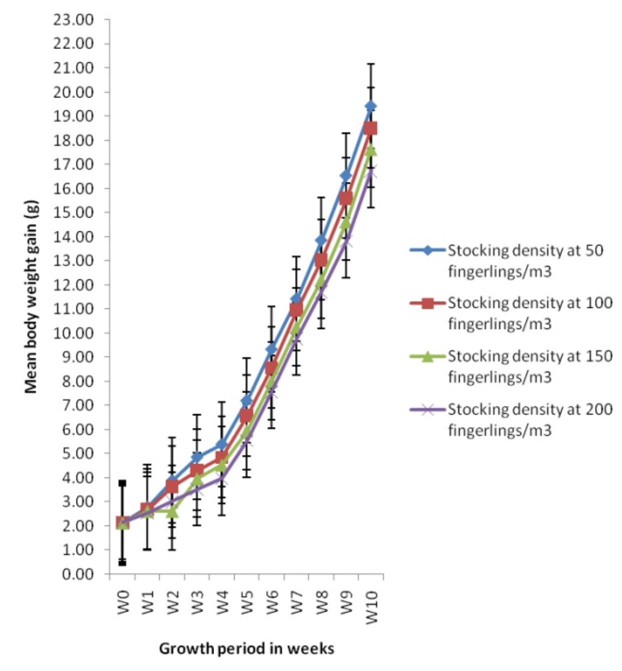
Ingredients	Percentage		
	1.5mm	2mm	3mm
Crude Protein	49%	42%	42%
Crude Fat	13%	13%	13%
Crude Ash	8.4%	7.1%	6.6%
Crude Fibre	1.0%	1.7%	1.6%
Phosphorus	1.3%	1.0%	1.0%
Calcium	1.8%	1.7%	1.5%
Sodium	0.4%	0.2%	0.2%

Source: Proximate analysis of Coppens feed by the producer

Table 2: Growth and Nutrient Utilization Parameters of the Experimental fish

Parameters	T_1(50)	T_2(100)	T_3(150)	T_4(200)
Experimental period (days)	70	70	70	70
Number of fish stocked	50	100	150	200
Final survival number	45	82	125	157
Survival rate (%)	90±1.16^{a}	82±1.86^{b}	83±0.67^{b}	78±0.67^{bc}
Total feed intake (g)	1152.00±10.35^{d}	2023.77±8.55^{c}	2901.03±9.00^{b}	3476.20±15.30^{a}
Average feed intake (g/day)	25.61±0.23^{a}	24.59±0.19^{b}	23.15±0.20^{c}	22.10±0.34^{d}
Initial mean weight (g)	2.14±0.01^{a}	2.14±0.01^{a}	2.14±0.01^{a}	2.14±0.01^{a}
Final mean weight (g)	19.42±0.03^{a}	18.52±0.02^{b}	17.65±0.03^{c}	16.74±0.04^{d}
Mean weight gain (g)	17.28±0.02^{a}	16.38±0.03^{b}	15.51±0.02^{c}	14.58±0.04^{d}
Mean daily weight gain(g/day)	0.25±0.00	0.23±0.00	0.22±0.00	0.21±0.00
Percentage mean weigh gain	809.41±3.78^{a}	765.59±3.28^{ab}	724.94±3.01^{ab}	677.41±3.80^{b}
Specific growth rate (%/day)	1.88±0.00^{a}	1.83±0.00^{b}	1.78±0.00^{b}	1.72±0.00^{c}
Relative growth rate(%/fish)	909.09±3.78^{a}	865.59±3.28^{ab}	824.94±3.01^{b}	777.41±3.77^{c}
Feed conversion ratio	1.50±0.02	1.54±0.02	1.53±0.01	1.57±0.01
Weekly protein intake(g/wk)	1.13±0.01	1.08±0.01	1.02±0.01	0.97±0.00
Protein intake (g)	11.30±o.10^{a}	10.83±0.09^{ab}	10.20±0.01^{b}	9.70±0.00^{c}
Protein efficiency ratio	1.53±0.02^{a}	1.51±0.01^{a}	1.52±0.02^{a}	1.50±0.00^{a}
Initial mean length (cm)	2.03±0.03^{a}	2.00±0.00^{a}	2.00±0.06^{a}	2.03±0.03^{a}
Final mean length (cm)	11.53±0.01	11.07±0.04	10.72±0.02	10.22±0.02

Figure 1:Growth response of *C. garipinus at different stocking density*



Discussion

Stocking density is one 0f the main factors determining fish growth (Engle and Valderrama 2001; Rahman et al .(2005) . in this study, stocking density of 50 fingerlings/m3 had the best weight gain of 17.28 and stocking density 200 fingerlings/m3 had the lowest weight gain of 14.58. This confirms that as stocking density increases, the mean weight gain decreases. This finding was similar to that of Anibeze et al. (2003) and Egwui (1987) who observed an inverse relationship between stocking density and daily average increase in weight of C. gariepinus. This therefore implies that adequate space should be allowed for fish growth in any fish production, since the lower the stocking density, the more the space available for the fish stocked. This is in agreement with the finding of Alahmad et al. (1988) which shows the mean size of Oreochromes spirulus fry reared at three stocking density for six weeks.

The highest specific growth rate of 1.88% per day was obtained in treatment T1 and later decreased to 1.83%, 1.78% and 1.72% per day in treatments T2, T3 and T4 respectively with increasing stocking density. There was a negative significant linear relationship between the stocking density and the specific growth rate (r = - 0.999) at $_{P}< 0.01$. This result suggests that stocking density has a marked effect on the growth rate of the experimental fish, as they would be competing for food and spaces. This result agrees with the findings of Oliver and Kaiser (1997) and Hossain et al. (1998); Refstie (1977; Li and Brocksen (1977); Leartherland and Cho (1985); Vijayan and Leartherland (1988); Holm et al. (1990). All of these observed that increasing stocking rates of different species of fish resulted in significant reduction in weight, and that growth rate was inversely correlated with the stocking density. The average feed intake recorded at the end of the experiment showed a decreasing order from 25.61±0.23g per day from treatment T1 to 24.59±0.19%, 23.15±0.20% and 22.10±0.34g per day in treatments T2, T3 and T4 respectively. This was seen as the effect of increased stocking density and decreased efficiency in search for food by the fish. This implies that there is a tendency for fish to consume more food when there is enough space. The relationship between the stocking density and average feed intake was significant at $_{P}< 0.05$, as it showed a strong negative correlation of r = - 0. 981. The highest feed conversion ratio of 1.58±0.01 was recorded in treatment T4 with highest stocking density, while the lowest ratio of 1.50±0.02 was recorded in treatment T1 with the least stocking density. This observed increased ratio could be attributed to increase in stocking density, which implies that there is a tendency for fish to consume more food when there is enough space/lower stocking density. The relationship between the stocking density and feed conversion ratio was significant at $_{P}< 0.05$ with a strong positive correlation of r = 0.769. This result is in agreement with the finding of Ellis et al. (2002); which affirmed that in rainbow trout, high density leads to increase in fin erosion, reduced feed intake, feed conversion efficiency, nutritional condition and growth.

Conclusions

From this study, the following conclusion could be drawn that adequate spacing of fish is important for fish growth in any fish production programme. Crowding of fish may result in stunted growth as observed in treatment T4(200 fingerlings/m^3). Optimum stocking density is therefore recommended for optimal growth, increase survival rate and efficient nutrient utilization in C. gariepinus. It is also recommended that good water parameters be maintained.

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