Journal of Fisheries International 2 (2): 182-185, 2007


# Effect of Stocking Density on Tilapia (*Oreochromis niloticus* Linnaeus 1757) Growth and Survival in Bamboo-Net Cages Trial

[1]S.A. Osofero, [2]S.O. Otubusin and [1]J.A. Daramola
[1]Department of Biological Sciences, Bells University of Technology, Ota, Ogun State, Nigeria
[2]Department of Aquaculture and Fisheries Management, University of Agriculture, Abeokuta, Ogun State, Nigeria

**Abstract:** A study was carried out to evaluate the effect of varying stocking densities on the growth, survival and yield of Tilapia (*Oreochromis niloticus* Linnaeus 1757) at the freshwater reservoir (average depth, 1.7 m) of the University of Agriculture Abeokuta, Nigeria for a period of 3 months. Tilapia juvenile with a mean weight of 29±4.81 g were randomly (Complete Randomized Design) stocked at 50, 100, 150 and 200 specimen per cage (1 $m^3$) were fed with commercial feed (34.55% Crude Protein). Twenty percent of stocked fish was sampled for growth forth nightly. P rofit index of the fish harvested under each treatment was evaluated. Relevant physico-chemical parameters like pH, conductivity, temperature, water depth and dissolved oxygen were also monitored forth nightly. The experimental fish and fish carcass (before the experiment and at harvest) from each treatment were analysed in replicates for their proximate composition. The growth response of the fish under the varying stocking densities was assessed, there were no significant differences ($p>0.05$) in Daily weight gain, Specific growth rate, Final weight, Relative growth rate, Feed Conversion Ratio (FCR), Survival, protein efficiency ratio for all the treatments, however there were significant differences ($p<0.05$) in fish production (harvest), profit index, crude protein, crude fat and ash composition of the fish carcass (at harvest). As stocking density increased, the crude protein content of the fish carcass decreased indicating an inverse relationship. The stocking density of 150 juvenile/cage with a final weight of 82.74 g per fish; FCR, 2.15; Survival, 99.35% and Fish production of 24.79 kg $cage^{-1}$ was considered best on the basis of the profit Index of 2.01 compared with the range of 1.45 to 1.82 for the other three treatments.

**Key words:** Stocking density, profit index, survival, growth

## INRODUCTION

The old proverb " Give a man a fish and you feed him for a day, teach him how to fish and you feed him for a life time" no longer holds. As human populations increase and natural fisheries resources diminish, knowing how to fish is not enough for today's fishers and their families; many would be better off learning how to culture fish or trying another trade altogether (Meryl, 1996).

Many small-scale farmers have failed to culture fish because of inadequate knowledge: Fry were stocked at too small a size and at too high density (Edwards and Demaine, 1988).

The main issues are availability of appropriate technology for the poor and access of the poor to public water bodies. This study presents an analysis of effects of varying stocking densities on growth and survival of Tilapia in eight 1$m^3$ experimental bamboo cages at the University of Agriculture, Abeokuta 3-hectare freshwater reservoir in Ogun State, Nigeria.

## MATERIALS AND METHODS

Eight bamboo cages (1×1×1 m) internally lined with net hapas were placed inside the University of Agriculture, Abeokuta, 3-hectare reservoir, with two-third of the cages immersed in water. The cages were tied to blocks (4 per each) which served as base with the aid of kuralon rope (No. 15).

The cages were randomly stocked with tilapia juveniles with a mean weight of 29.54±4.81 g at 50, 100, 150 and 200 per cage (replicated thrice) corresponding to treatments I, II, III and IV, respectively. All the fish throughout the three months culture period were fed twice daily, 6 days per week at a rate of 5% of their biomass for the first month and 3% of their biomass for the rest of the culture period.

After 3 months of culture, the cages were moored to the shore of the reservoir where the fish were harvested, counted, measured and weighed. Fish sampling were carried out forth nightly, this was usually conducted in

**Corresponding Author:** S.A. Osofero, Department of Biological Sciences, Bells University of Technology, Ota, Ogun State, Nigeria

the morning between 7:30 and 9:00 using a scoop net. During sampling 20% of the stocked fish in each cage was scooped out and weighed using Philips electronic kitchen scale. As the water level reduced, the cages were relocated to maintain approximately the same level of water in the cages. The fish were harvested at the 90th day by moving the cages to the shore one after the other. All the fish inside the cages were scooped out for mass weighing per cage and the total number of fish in each cage counted.

To determine the growth response of the fish, the following parameters were calculated; Mean Weight Gain (MWG), Feed Conversation Ratio (FCR); Relative Growth Rate (RGR) Specific Growth Rate (SGR), Protein Efficiency Ratio (PER); Mortality and Survival Rate.

**Mean Weight Gain (MWG):**

$$MWG = Wt_2 - Wt_1$$

Where $Wt_1$ = Initial mean weight of fish at time $T_1$
$Wt_2$ = Final mean weight of fish at time $T_2$

**Feed Conversion Ratio (FCR):**

$$FCR = \frac{\text{Weight of feed given (g)}}{\text{Fish weight gain (g)}}$$

**Relative Growth Rate (RGR):**

$$RGR\ (\%) = \frac{(W_f - W_i) \times 100}{W_i}$$

$W_f$ = Final average weight at the end of the experiment.
Wi = Initial, average weight at the beginning of the experiment.

**Protein Efficiency Ratio (PER):**

$$PER = \frac{\text{Fish Weight Gain (g)}}{\text{Protein Intake (g)}}$$

**Specific Growth Rate ( SGR ):**

$$SGR = \frac{\log e W_f - \log e W_i \times 100}{\text{Time (days)}}$$

Where
$W_f$ = Final average weight at the end of the experiment
$W_i$ = Final average weight at the beginning of the experiment.
Loge = Natural logarithm reading
Time = Number of days for the experiment (91 days).

**Mortality and survival rate (%):**

$$\text{Survival rate (\%)} = \frac{\text{Number of fish that survived} \times 100}{\text{Total number of fish stocked}}$$

Proximate analysis of feed and fish carcass were done according to the procedure in AOAC (1993).

Data collected were analysed using analysis of variance technique (Steel and Torries, 1980). Significant difference in means were separated using Duncan Multiple Range Test (1955) all the statistical test was done on SPSS 10 version for Windows (1999).

## RESULTS

The percentage survival rates of fish in all the treatments at harvest were presented in Table 1, the mean survival rate ranged between 98.5 and 99.5%, treatment II had the highest survival rate of 99.5% and treatment IV had the lowest survival rate of 98.5%, mortality was first observed in treatment IV during the second week of culture. The result of this study indicated an inverse relationship between survival rate and stocking density. Table 1 shows the summary of the initial and final average weights (g) of fish, Daily Weight Gain (DWG: g $day^{-1}$), Relative Growth Rate (RGR) and Specific Growth Rate (SGR: %/day)

Treatment I with 50 juveniles/cage had the highest final mean weight of 111.66 g, while treatment III had the lowest weight of 82.74 g. Values of daily weight gain were not significantly different for all the treatments, but there were perfect correlation between Daily Weight Gain of Tilapia (*Oreochromis niloticus* Linnaeus 1757) and protein intake, significant at the 0.01 level, Daily weight Gain was also positively correlated with Crude protein at 0.05 level of significance. The ability of the fish to convert feed given to flesh decrease as stocking density increased, except for treatment II which had a higher Feed Conversion Ratio than Treatment I, this could be explained as due to the higher water volume in cages under treatment II (0.62 $m^3$) compared to the water volume in cages under treatment I (0.59 $m^3$).

The fish production increased as the stocking density increased, the production was generally high in this experiment, high production obtained could be attributed to high crude protein content of the feed, the favourable physico-chemical conditions of the reservoir and the design of the cage whereby it was internally lined allowed for the maximum utilization of the feed.

Table 1: Summary of the growth performance at different densities of tilapia (*Oreochromis niloticus*) cultured in bamboo-net cages for 91 days

| Treatment | Initial weight (g) | Final weight (g) | Weight gain (g) | RGR (%) | SGR % $day^{-1}$ | FCR | Survival (%) | DWG (g $day^{-1}$) | Production (Kg $cage^{-1}$) | Water depth (m) | PER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I 50/cage | 32.5 | 111.66 | 79.16 | 242 | 1.35 | 1.92 | 99.00 | 0.88 | 8.83[a] | 0.61 | 0.94 |
| II 100/cage | 25.75 | 93.65 | 67.9 | 267 | 1.43 | 1.56 | 99.50 | 0.76 | 13.9[b] | 0.59 | 1.26 |
| III 150/cage | 29.15 | 82.74 | 53.59 | 183 | 1.14 | 2.15 | 99.35 | 0.59 | 24.79[c] | 0.50 | 0.86 |
| IV 200/cage | 30.75 | 84.02 | 53.27 | 179 | 1.11 | 2.21 | 98.50 | 0.59 | 28.56[c] | 0.59 | 0.89 |

[abcd]Values with different superscript in the same column were significantly different at $p<0.05$. Weights are mean weight per treatment, Where, SGR: Specific Growth Rate, FCR: Feed Conversion Ratio, RGR: Relative Growth Rate, DWG: Daily Weight Gain, PER: Protein Efficiency Ratio

Table 2: Means and ranges of some physico-chemical parameters of water inside the cages for 91 days culture period

| | Treatments | | | |
|---|---|---|---|---|
| Parameters | I | II | III | IV |
| Conductivity (µs $cm^{-1}$) | 199.8 (161.3-230) | 200.9 (159.95-234.5) | 200.9 (160.25-231.5) | 200.8 (161-230) |
| pH | 7.33 (6.88-7.75) | 7.27 (6.99-7.43) | 7.35 (6.97-7.76) | 7.23 (6.90-7.69) |
| Temperature (°C) | 30.00 (29-31.3) | 30.2 (29.5-32) | 30.2 (29.5-31.3) | 30.8 (29.5-32.9) |
| Dissolved oxygen Mg $L^{-1}$ | 2.7 (2.3-3.2) | 2.5 (2.0-3.3) | 2.0 (1.5-2.7) | 1.4 (1.1-1.6) |

Table 3: A summary of cost benefit evaluation results

| | Treatments | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| Production period (days) | 91 | 91 | 91 | 91 |
| Stocking density (per cage) | 50 | 100 | 150 | 200 |
| Net production (kg/cage/91days) | 8.832 | 13.944 | 24.789 | 28.558 |
| Value of fish @ N200.00 $kg^{-1}$ | 1766.4 | 2788.8 | 4957.8 | 5711.6 |
| Feed input (kg) | 10.55 | 14.05 | 23.55 | 31 |
| Cost of feed $kg^{-1}$ (N) | 50 | 50 | 50 | 50 |
| Cost of feed used (N) | 527.50 | 702.50 | 1177.50 | 1550.00 |
| Cost of fingerling (N) | 300.00 | 600.00 | 900.00 | 1200.00 |
| Cost of cage | 387.50 | 387.50 | 387.50 | 387.50 |
| Total cost of production | 1215.00 | 1690.00 | 2465.00 | 3137.00 |
| Gross profit (N) | 551.40 | 1098.80 | 2492.80 | 2574.10 |
| Profit index | 1.45[a] | 1.65[b] | 2.01[c] | 1.82[d] |

[abcd]Values with different superscript in the same row were significantly different at $p<0.05$

Water quality parameters measured in the cages included pH measured using oxyguard handy meter (7.23-7.35); temperature range measured using mercury-in-glass thermometer (30-30.8°C); conductivity measured using jenway 4310 conductivity meter(199.8-200.9 µs $cm^{-1}$) and dissolved oxygen measured using oxyguard handy meter (1.1-3.3 mg $L^{-1}$) (Table 2).

## DISCUSSION

The culture of Tilapia (*Oreochromis niloticus*) juvenile in cages at high densities seems to be feasible if these results are compared to those obtained in conventional culture of tilapia in cages. Treatment II had the highest survival rate of 99.5% which was comparable with survival for Tilapia (99%) cultured in cages by Alev and Dikel (2003) in Seyham Dam lake. The result of this study indicated an inverse relationship between survival rate and stocking density. The daily weight gain obtained for treatment III 0.59 g day-1 was higher than the highest 0.34±0.015 g $day^{-1}$ obtained by David *et al*. (2005) and 0.27±0.00 g $day^{-1}$ reported by Ouattara *et al*. (2003) with the same stocking density. High production obtained in this experiment could be attributed to high crude protein content of the feed, the favourable physico-chemical conditions of the reservoir and the design of the cage whereby it was internally lined allowed for the maximum utilization of the feed.

The profit index for all the cages were significantly different ($p<0.05$) Table 3.

The higher profit index in treatment III over that of treatment IV probably pointed to the fact that 150 juveniles per cage (1 $m^3$) may be better in economic terms than 200 juveniles per (1 $m^3$). This is also reflected in the lack of significant difference ($p>0.05$) in the FCR and SGR for all the treatments, it is therefore apparent that biological and economic benefit will be achieved in intensive cage culture of tilapia juvenile when stocked at 150 juveniles $m^{-3}$.

## REFERENCES

Alev and A. Dikel, 2003. Tilapia-A successful second crop to trout, fish farmer International file, pp: 28-30.

Association of Official Analytical Chemists (AOAC), 1993. Official Method of Analysis (15th Edn.) AOAC Washington DC, USA.

David, M.L., F. Bernard, M.M. Jonathan, S. Michael, W. Herwig and W. Gerold, 2005. Effects of open-pond density and caged biomass of NileTilapia (*Oreochromis niloticus* L.) on growth, feed utilization, economic returns and water quality in fertilized ponds. Aqu. Res., 36: 1535-1543.

Duncan, D.B., 1955. Multiple Range and Multiple F-Test Biometric, 11: 1-12.

Edwards, P. and H. Demaine, 1988. Rural Aquaculture: Overview and Framework for country reviews. RAP Pub. 1997/36. Rap/fao. Bangkok.

Meryl Williams, 1996. The transition in the contribution of Living Aquatic resources to food security, food and environmental Discussion paper 12, Int. Food Policy, Res. Inst. Washington D.C., pp: 1.

Ouattara, N.I., G.G. Teugels, V.N. Douba and J.C. Philippart, 2003. Aquaculture potential of the black 190 chinned tilapia, *Sarotherodon melanotheron* (Cichlidae). Comparative study of the effect of stocking density on growth performance of landlocked and natural populations under cage culture conditions in Lake Ayame (Coˆte d'Ivoire) Aqu. Res., 34: 1223-1229.

SPSS for Windows, 1999. Release 10.0.1 copyright SPSS incorporated.

Steel, R.D.G. and J.H. Torries, 1980. Principles and procedure of statistics. Biometric approach, (2nd Edn.), McGraw Hill Book Co. Inc, New York.