World Journal of Fish and Marine Sciences 4 (3): 320-324, 2012
ISSN 2078-4589

DOI: 10.5829/idosi.wjfms.2012.04.03.6230

Growth Performance of Nile Tilapia (*Oreochromis niloticus*) as Affected by Stocking Density and Feed Types in Water Flow Through System

[1]*A.F. Yakubu,* [2]*A. Obi,* [2]*V.A. Okonji,* [1]*O.O. Ajiboye,* [1]*T.E. Adams,* [1]*E.D. Olaji and* [1]*N.A. Nwogu*

[1]Nigerian Institute for Oceanography and Marine Research, Sapele, Delta State, Nigeria
[2]Department of Fisheries, University of Benin, Benin City, Nigeria

Abstract: Mixed-sex population of Oreochromis niloticus fingerlings were collected from a reputable farm and acclimatized for a week and randomly stocked at three densities of 300 fish m-3, 450 fish m-3 and 600 fish m-3 in twelve (12) circular fiber glass tanks, each with capacity of 3.08m3 of water at a nominal flow rate of 2L/min. Each stocking densities were fed with two types of feed {Multi feed (foreign), NIOMR feed (local)}. Each density/feed combination represents a treatment and each treatment replicated twice for statistical validation. Based on this present study, overall growth rate differed significantly among treatment ($P<0.05$) with low and intermediate stocking density treatments having higher growth than the high density treatment but with significant difference between the two different types of diet. On the other hand, the results of the experiment indicated that fish that were fed Multi feed diet had similar mean weight and percentage weight gain and grow significantly better ($P<0.05$) than those fed with NIOMR diet, although no significant difference was observed in specific growth rate between the NIOMR and Multi feed diet among all the treatments. In terms of the feed conversion ratio (FCR) between fish fed NIOMR feed and Multi feed, it was observed that the fish fed Multi feed had the best feed conversion ratio. Observations during this research indicated no record of spawning in any of the fiber tanks throughout the culture period of 24 weeks. Thus, it could be asserted that intensive tank culture of Nile tilapia in a flow-through system is a successful culture system in controlling excessive reproduction of O. niloticus. Overall results therefore recommended the suitability of NIOMR feed and Multi feed as a diet for O. niloticus fingerlings.

Key words: Nile Tilapia % *Oreochromis niloticus* % Stocking Density % Water Flow Through % NIOMR Feed % Multi Feed

INTRODUCTION

The Nile tilapia, *Oreochromis niloticus* (Linnaeus) is widely cultured in many tropical and subtropical countries of the world [1, 2]. It provides one of the major sources of animal protein and income throughout the world [3,4]. Farmed tilapia production throughout the world increased dramatically in recent years, increasing from 383,654 mt in 1990 to 2,326,413 mt in 2006 [5].

Because of their faster growth rate, tolerance to harsh environment and ease culture technique, tilapia offers the possibility of commercial and home-grown protein sources where wild capture fisheries are being depleted [6, 7]. However, the major concern for tilapia aquaculture is excessive reproduction and the resulting small size of the produced fish [8]. The success of the culture methods applied for tilapia farming depend on various factors and determination of the optimal method under a certain condition can be quite complex [9]. Various traditional and non-traditional tilapia farming methods are adapted in different countries in accordance with the socio-economic and ecological condition of that place [8, 10]. It is often culturing in earthen ponds without supplemental feeding [11]. Besides, flow-through technology can be applied in many tropical locations where large volumes of warm flowing water are available [12]. On the other hand, the adoption of this modern intensive culture system (flow-through technology) which requires supplementary feeding, maintenance of good water flow and constant close monitoring in the control of the early sexual maturity

Corresponding Author: A.F. Yakubu, Nigerian Institute for Oceanography and Marine Research, P.M.B. 4015, Sapele, Delta State, Nigeria.

that leads to overcrowding in the pond and thus stunted growth has received little attention in tilapia farming. Thus, the main objective of this study was to establish an optimal method under a certain condition for the culture of Nile tilapia by comparing the growth pattern of *O. niloticus* as affected by stocking density and feed types (NIOMR feed and Multi feed) in water flow through system.

MATERIALS AND METHODS

The study was conducted at the Nigerian Institute for Oceanography and Marine Research, Sapele, Delta State, Nigeria. Twelve (12) circular fiber glass tanks were used, each with capacity of 3.08m^3 of water at a nominal flow rate of 2L/min (Plate 1). The tank was mounted indoor in a flow through and arranged in a row. Mixed-sex population of *O. niloticus* fingerlings were collected from a reputable farm and acclimatized for a week and randomly stocked at three densities of 300 fish m^3, 450 fish m^3 and 600 fish m^3. Each stocking density was fed with two types of feed {Multi feed (foreign), NIOMR feed (local)}. Each density/feed combination represents a treatment and each treatment replicated twice for statistical validation.

Sampling of the cultured fish was carried out bi-weekly for a period of 24 weeks for the collection of data to determine the variation among the treatments. Throughout the entire culture, period different water quality parameters like temperature, dissolved oxygen, pH, nitrate, nitrite and total ammonia were regularly monitored.

Plate 1: Showing fiber glass tanks used in the study

Data collected were subjected to statistical test using analysis of variance (ANOVA). Mean separation was done using Duncan Multiple Range Test and Least Significant Difference. All tests were carried out at 5% probability level ($P < 0.05$) [13]. The Genstat Statistical Package (version 8.1) was used for the analysis.

RESULTS

Data on fish growth performance for NIOMR feed diet and Multi feed diet at different stocking densities is presented in Fig. 1.

Fish growth rate proceeded in a linear fashion throughout the experiment (Fig. 1). Overall growth rate differed significantly among treatments ($P<0.05$) with low and intermediate stocking density treatments having higher growth than the high density treatment but with

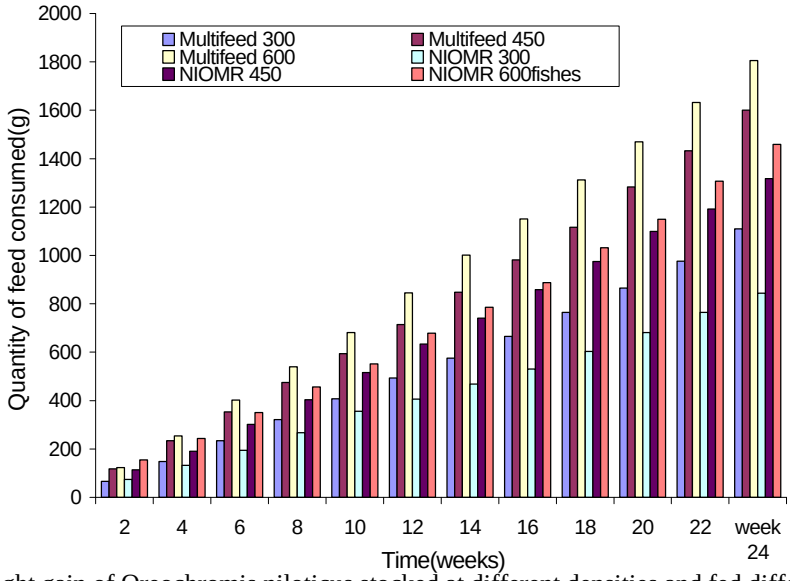

Fig. 1: Bi-weekly weight gain of Oreochromis niloticus stocked at different densities and fed different types of feed

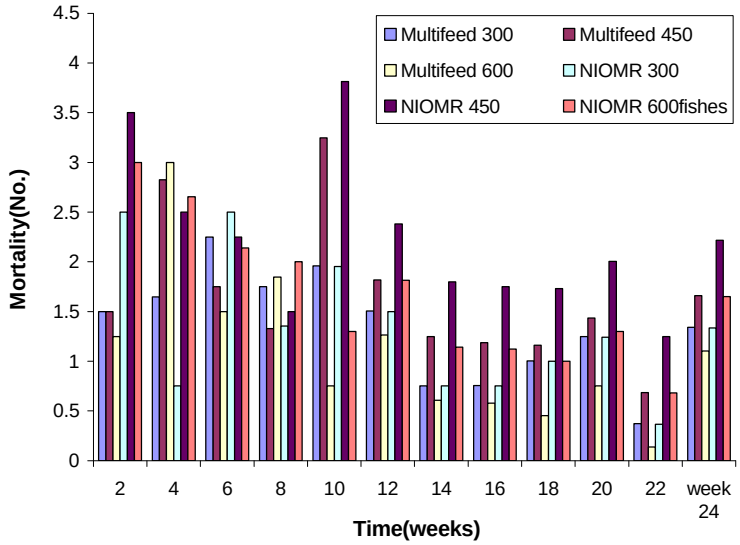

Fig. 2: Mortality of stocked fish feed different feed types at various stoking density over time

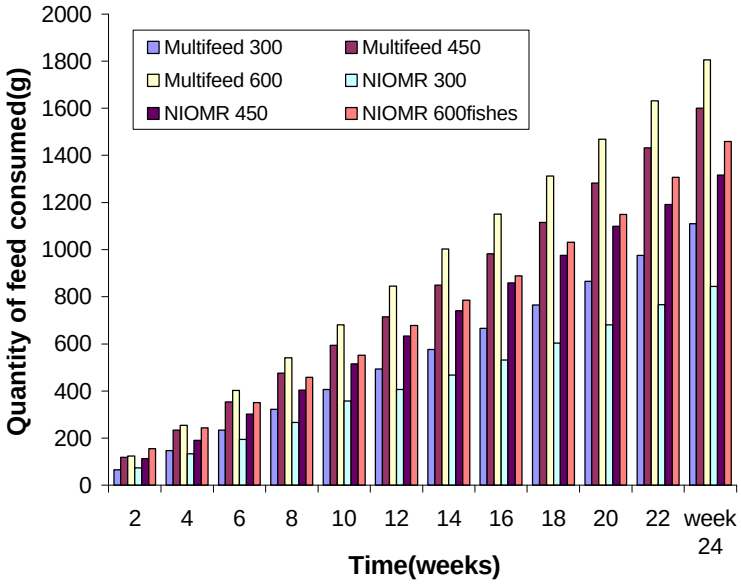

Fig. 3: Quantity of Feed Consumed for various feed type over Time

Table 1: Growth performance of *Oreochromis niloticus* fed Multi feed and NIOMR feed in a water flow through system

Parameters	Niomr Feed (300/tank)	Multi Feed (300/tank)	Niomr Feed (450/tank)	Multi Feed (450/tank)	Niomr Feed (600/tank)	Multi Feed (600/tank)
Initial weight (g)	6.19^{b}	5.5^{c}	6.28^{b}	6.57^{a}	6.14^{b}	5.15^{d}
Final weight (g)	72.53^{e}	93.76^{a}	74.71^{d}	89.82^{b}	61.31^{f}	75.95^{c}
Weight gain (g)	66.34^{e}	88.26^{a}	68.43^{d}	83.25^{b}	55.17^{f}	70.8^{c}
Specific Growth Rate (%/day)	1.46^{a}	1.69^{a}	1.47^{a}	1.56^{a}	1.37^{a}	1.60^{a}
Survival rate (%)	94.0^{b}	97.0^{a}	95.6^{b}	98.0^{a}	98.3^{a}	98.7^{a}
Feed intake (g feed/fish)	443.6^{f}	552.4^{e}	694.9^{d}	812.6^{b}	754.7^{c}	934.7^{a}
Mortality	1.33^{c}	1.34^{c}	2.23^{a}	1.65^{b}	1.65^{b}	1.10^{c}
Feed conversion Ratio	6.69^{c}	6.26^{c}	10.15^{b}	9.76^{b}	13.68^{a}	13.20^{a}

Abcdef: Means with different subscripts along the same row are significantly different (P<0.05)

significant difference between the two different types of diet. In addition, fish that were fed Multi feed diet had similar mean weight and percentage weight gain and grow significantly better ($P<0.05$) than those fed with NIOMR diet (Table 1). However, there were no significant differences in specific growth rate between the NIOMR and Multi feed diet in all the treatments. Similarly, mortality rate varied among treatments with high mortality in the intermediate density treatment at 10^{th} week for NIOMR feed diet with no significant difference between the lower and the higher density treatments ion fish fed with Multi feed (Fig. 2).

Feeding rate increased as the fish grow in all the treatments (Fig. 3). There is no significant difference in the feeding rates among the treatments ($P>0.05$) but differed significantly among tested diets ($P<0.05$). In terms of the feed conversion ratio (FCR) between fish fed NIOMR feed and fish fed Multi feed, it was observed that the fish fed Multi feed at 300 fish/m^3 had the best FCR.

Most physical and chemical variables showed no significant difference among treatments ($P>0.05$). The only exception where pH was significantly different was in the fish fed NIOMR diet in treatment (450 fish/tank) at week 10 of the experimental period. Dissolved oxygen levels was not significantly different ($P>0.05$) among treatments while NH_3 and total ammonia were significantly higher ($P<0.05$) in fish fed NIOMR feed than those fed Multi feed in week 10 of the experimental period. Dissolved oxygen was not significantly different ($P>0.05$) in all the treatments but slightly low in fish fed with NIOMR feed at 450 fish/tank at week ten (10).

DISCUSSION

The results of the study shows that growth rates, feed conversion rate and survivorship were favorable in fish fed with Multi feed and NIOMR fed fish containing 300 fish/tank and 450 fish/tank as compared to tanks feed with NIOMR feed and Multi feed at 600 fish/tank.

Size distribution analysis in terms of (bi-weekly weight gain) indicates that at the lower stocking densities of 300 fish/tank and 450 fish/tank, there was a higher weight gain. At the higher stocking densities of 600 fish/tank, the size was smaller, with many smaller fish being harvested. This observation could be as a result of the argument made by [14] in a study conducted on the effects of stocking density on growth, yield and profitability of farming Nile tilapia *O. niloticus* fed Azolla diet in earthen pond. His argument was based on the stocking density cited as inhibitory factor for fish growth. [15, 16] argued that competition for food could also be a possible factor. Space limitation [15-17] and low dissolved oxygen were highlighted as other factors. [18, 19] argued that tilapia is a territorial and aggressive fish so that the density effect on growth might be explainable by their competition for territories, as well as the permanent stress caused by crowding.

Survival rates were not affected by stocking density which is consistent with [20] who reported that mortality in Nile tilapia raised in cages was not dependent on stocking density, though in this study there was high mortality at week 10 in the fish fed with NIOMR feed in 450 fish/tank. This was due to poor water quality as a result of pollution with excess feed. Other reports on catfish support these findings [21, 22]. However, it must also be well noted that the effects of density on survival rate could be entirely dependent on the range of stock densities. T ilapia cultures are fraught with the problems of prolific breeding, overpopulation and stunting. *O. niloticus* sexually matures at about 20 g weights [23], but throughout the culture period of 24 weeks there were no record of spawning in any of the tanks since there was no fry or small fish observed. This could be attributed to the constant flow rate of the water and the high stocking density of the fish in this study unlike the earthen pond culture. This is in agreement with [24] who reported that intensive tank culture offers several advantages over the use of ponds in the sense that the high density of fish in tanks disrupts breeding behavior and allows male and female tilapia to be grown together to marketable size. This result is encouraging for the future of this system since there are concerns about tilapia that have been genetically modified using hormones [25].

CONCLUSION AND RECOMMENDATION

Results of this experiment show an excellent overall growth performance and status of tilapia. These recommend the suitability of NIOMR feed and Multi feed as a diet for *O. niloticus* fingerlings. More also, inability of *O. niloticus* to spawn during the experimental period shows that the flow-through system is a successful culture system in controlling excessive reproduction of *O. niloticus*. It is important to determine the apparent digestibility of the two diets. The effect of crude protein content on the digestibility of the diets ought to be verified. There is also a need to determine the economic profitability of the culture system.

REFERENCES

1. Lin, Y.H., S.M. Lin and S.Y. Shiau, 2008. Dietary manganese requirements of juvenile tilapia, *Oreochromis niloticus* x *O. aureus*. Aquaculture, 284: 207-210.
2. Authman, M.M.N., M.A. El-Kasheif and K.A.S. Shallof, 2009. Evaluation and management of the fisheries of *Tilapia* species in Damietta branch of the River Nile, Egypt. World J. Fish and Marine Sci., 1(3): 167-184.
3. Sosa, I.D.L.A.B., M.D.L.J. Adillo, A.L. Ibanez and J.L.I.A. Figueroa, 2005. Variability of tilapia (*Oreochromis* spp.) introduced in Mexico: Morphometric, meristic and genetic characters. J. Applied Ichthyol., 20: 7-10.
4. El-Bokhty, E.E.B., 2010. Fisheries management of *Oreochromis niloticus* and *Oreochromis aureus* caught by trammel nets ands basket traps in Lake Manzalah, Egypt. World J. Fish and Marine Sci., 2(1): 51-58.
5. Food and Agriculture Organization of the United Nations (FAO), 2007. FAO Fish Stat plus Aquaculture production, pp: 1970-2002. Rome.
6. Mandal, S.C., M. Hasan, M.S. Rahman, M.H. Manik, Z.H. Mahmud and M.D.S. Islam, 2009. Coliform bacteria in Nile Tilapia, *Oreochromis niloticus* of shrimp-*Gher*, pond and fish market. World J. Fish and Marine Sci., 1(3): 160-166.
7. Palipoch, S., W. Jiraungkoorskul, T. Tansatit, N. Preyavichyapugdee, W. Jaikua and P. Kosai, 2011. Effect of *Thunbergia laurifolia* (Linn) leaf extract dietary supplement against lead toxicity in Nile Tilapia (*Oreochromis niloticus*). World J. Fish and Marine Sci., 3(1): 01-09.
8. Lèveque, C., 2002. Out of Africa: the success story of tilapias. Environ. Biol. Fishes, 64: 461-464.
9. Graaf, G.J., P.J. Dekker, B. Huisman and J.A.J. Verreth, 2005. Simulation of Nile tilapia (*Oreochromis niloticus* L.) culture in ponds, through individual-based modeling, using a population dynamic approach. Aquaculture Res., 36: 455-471.
10. Chakraborty, S.B. and S. Banerjee, 2009. Culture of monosex Nile Tilapia under different traditional and non-traditional methods in India. World J. Fish and Marine Sci., 1(3): 212-217.
11. Liti, D.M., B. Fulanda, J.M. Munguti, M. Straif, H. Waidbacher and G. Winkler, 2005. Effects of open-pond density and caged bio-mass of Nile tilapia (*Oreochromis niloticus* L.) on growth feed utilization, economic returns and water quality in fertilized ponds. Aquaculture Res., 36: 1535-1543.
12. Soderberg, R.W., 2006. Culture in flowing water. C. Lim, C.D. Webster (Eds.), Tilapia: Biology, Culture and Nutrition, Haworth Press, Binghamton, NY, USA: pp: 289-312.
13. Duncan, D.B., 1955. Multiple Range and Multiple F-Tests. Biometrics, 11: 1-42.
14. Youssouf Abou, E.D.F. and M. Jean-Claude, 2007. Effect of stocking density on growth, yield and profitability of farming Nile tilapia *O. niloticus* L. fed Azolla diet in earthen pond. J. Aquaculture Res., pp: 595-603.
15. Helser, T.E. and F.P. Almcida, 1997. Density-dependent growth and sexual maturity of silver hake in the northwest Atlantic. J. Fish Biol., 51: 607-623.
16. Irwin S., J. O'Halloran and R.D. FitzGerald, 1999. Stocking density, growth and growth variation in juvenile turbot, *Scophthalmus maximus* (Rafinesque). Aquaculture, 178: 77-88.
17. Islam, M.S., 2002. Evaluation of supplementary feeds for semi-intensive pond culture of mahseer, *Tor putitora* (Hamilton). Aquaculture, 212: 263-276.
18. Yi, Y., C.K. Lin and J.S. Diana, 1996. Effects of stocking densities on growth of caged Nile tilapia (*Oreochromis niloticus*) and on yield of small tilapia in open pond water in earthen ponds. Aquaculture, 146: 205-215.
19. Huang, W.B. and T.S. Chiu, 1997. Effects of stocking density on survival, growth, size variation and production of tilapia fry. Aquaculture Res., 28: 165-173.
20. Daungsawasdi, S., C. Chomchei, R. Yamorbsin and B. Kertkomut, 1986. Net cage culture of Tilapia and Puntius in Klong Praew Irrigation Tank. Technical Paper NIFI No. 64. Bangkhen, Bangkok, Thailand, pp: 10.
21. Haylor, G.S., 1992. Controlled hatchery production of *Clarias gariepinus* (Burchell): growth and survival of larvae at high stocking density. Aquaculture and Fisheries Manage., 23: 303-314.
22. Islam, M.S., M.M. Rahman and M. Tanaka, 2006. Stocking density positively influences the yield and farm profitability in cage aquaculture of sutchi catfish, *Pangasius sutchi*. J. Applied Ichthyol., 22: 441-445.
23. Mair, G.C. and D.C. Little, 1991. Population control in farmed tilapia. NAGA, ICLARM Q. 17(4): 8-13.
24. DeLong, D.P., T.M. Losordo and J.E. Rakocy, 2009. Tank culture of tilapia. Southern Regional Aquaculture Centre Publication. 282: 1-8.
25. Ranmarine, I.W., 2003. Marketing of tilapia. Paper presented at ASA tilapia farming workshop, Kingston, Jamaica. pp: 12.