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Research Article

Effect of Stocking Density on the Growth and Performance of Nile Tilapia (*Oreochromis niloticus*) Fingerlings Reared in Fiberglass Tanks

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Received: March 13, 2021; **Published:** April 12, 2021

Abstract

This study was conducted to investigate the effect of stocking density on growth and performance of fingerlings of the Nile tilapia (*Oreochromis niloticus*) reared in fiberglass indoor tanks. The experiment designed of four treatments of different stocking densities (80, 160, 240 and 320 fish/m^3) corresponding to density classes (A, B, C and D) respectively. Each treatment is replicated in three fiberglass tanks. All fish in the study was fed with a commercial diet (35% protein) at a rate of 6% of their body weight/day for 12 weeks then changed to 4% for the last week, six days a week. The results showed that the growth rate in this study increase with increase stocking density, the final mean weight recorded highest weight at (27.6g) for treatment (C), followed by treatment (D) it recorded (27.1g) and (22.5g) for treatment (B), while treatment (A) recorded lowest weight at (20.1g). Statistical analysis revealed there were no significant differences at ($p > 0.05$) between four treatments in (WG, WG%, DGR and SGR%,). Also, result showed that the percent of weight gain, weight gain, daily growth rate, and specific growth rate were positively proportional with stocking density; While the food conversion rate were affected inversely with stocking density. The survival rate (SR%) result Showed there were significant differences ($P < 0.05$) between treatments (A) and (D), where treatment (A) recorded the highest survival rate (80%), followed by treatment (C) (70%), treatment (B) (65.8%) and treatment (D) recorded the lowest survival rate (46.25%). Water quality characteristics showed significant differences at ($p < 0.05$) between all treatments. Result of ammonia (NH_3), nitrite (NO_2^-), and nitrate (NO_3^-) showed increase in concentration with increase stocking density, while DO and pH decreased with increase stocking density. The study concluded that the highest recorded the best stocking density is of treatment (C), it can be considered the optimum density for growing tilapia fish in fiberglass tanks.

***Keywords**: Nile Tilapia; Stocking Density; Growth Performance and Water Quality*

Introduction

Stocking density is considered one of the important factors affecting fish growth and determines the success or failure of intensive culture of tilapia [1,2]. Extensive research has been conducted on the effect of stocking density on tilapia production in various intensive culture systems. The available information revealed controversial results, while negative correlation usually occurs between stocking density and individual fish growth. Similarly, El-sayed [3] found that the fish survival, percentage weight gain, and specific growth rate (SGR %) were negatively correlated with stocking density. He suggests the best performance was achieved at 3 fry/L^{-1}.

Aquaculture in Sudan rapidly expanded in the past couple of years especially in Khartoum, Gazira and north Sudan States, but with little success.

Objectives of Study

- To determine the optimum stocking density on the growth and performance of fingerlings of Nile tilapia (*Oreochromis niloticus*).
- To evaluate intensive tank culture with water quality management.

Materials and Methods

Study site

This study was conducted at the wet-Lab unite in the fish farm located in South of Jebel Awlia Reservoir, which is affiliated to the Fish Science Department- Faculty of Agricultural Technology and Fish Sciences- Neelain University, during the period from October 2019 to January 2020 which extended for a period of 13 week (91 days).

Fish of experiment

Fingerlings of the Nile tilapia (*Oreochromis niloticus*) (85% male) used in the study were collected from the nursery ponds of fish farm, and their average weight was about 4 - 5 gram, and they were adapted to the fiberglass tanks and provided with an artificial diet during a week.

Tanks and system culture preparation

Twelve circular fiberglass indoor tanks prepared for the experiment are equipped with an open running water system, each tank is equipped with a water supply pipe, filled with ($1m^3$) of well water, and provided with central drainage pipes surrounded outer sleeves pipes, perforated at the bottom, to facilitate self-cleaning and waste removal. The water flow rate was adjusted a twice turn-over per day (350 ml/min) to provide suitable water quality conditions. All tanks were provided with sufficient aeration, each tank connected with small air pump with two air stone.

Experimental design

The experiment designed of four treatments of different stocking densities (40, 160, 240, and 320 fish/m^3) corresponding to density classes (A, B, C and D) respectively. Each treatment is replicated in three fiberglass tanks. All fish in the study was fed with a complete diet (35% protein) at a rate of 6% of their body weight/day for 12 weeks then changed to 4% for the last week, six days a week. This diet divided into two equal doses during the day (8:00 AM and 2:00PM). All fish in each tank was weighed in the beginning and at the end of the experiment by used sensitive balance (SF-400 accuracy of 1g). They were also weighed once every week to follow growth rates and readjust the daily feed allowance for the next week. Performance was assessed based on weight gain (WG), daily growth (DG), specific growth rate (SGR %), food conversion ratio (FCR) and survival rate (SR %).

Water quality analysis

Water quality parameter including dissolved oxygen (DO), ammonia (NH_3), nitrite (NO^-_2), nitrates (NO^-_3), and pH were monitored every 15 days by using DO meter (DO-5509), pH meter, and fresh water master test Kits. For temperature, it was measured daily by a regular thermometer.

Statistical analysis

The data of growth performance parameters, survival rate and the water quality parameters were analyzed for the study by using SPSS 21 - ANOVA one way and excel software. Statistical significance was determined at ($p < 0.05$) level. Least significant difference (LSD) was used to test for the differences.

Results

result showed that there were non significant ($p > 0.05$) between the treatments in weight gain, weight gain%, daily growth rate, Feed Conversion Ratio and specific growth rate. While the Survival Rate % showed there is significant between the treatments ($p < 0.05$) special between A and D with stocking density (Table 1). Statistical analysis showed there were significant differences when used (LSD) at ($p < 0.05$) between treatments in all water quality parameters (Table 2).

Parameters	Treatments			
	A M ± SD	B M ± SD	C M ± SD	D M ± SD
Initial weight (g/fish)	4.3 ± 0.3^a	4.6 ± 0.4^a	4.9 ± 0.4^a	4.8 ± 0.3^a
Final weight (g/fish)	20.1 ± 3.5^a	22.5 ± 2^a	27.6 ± 7.1^a	27.1 ± 4.4^a
Weight gain (g/fish)	15.8 ± 3.3^a	17.8 ± 1.8^a	22.6 ± 6.9^a	22.2 ± 4.1^a
Weight gain (%)	366.4 ± 58.4^a	384 ± 43.6^a	458.3 ± 125.6^a	455.7 ± 66.1^a
Daily Growth Rate (g/fish/day)	0.17 ± 0.03^a	0.19 ± 0.02^a	0.24 ± 0.07^a	0.24 ± 0.03^a
Specific Growth Rate (SGR) (%)	1.6 ± 0.15^a	1.7 ± 0.1^a	1.9 ± 0.3^a	1.85 ± 0.13^a
Food Conversion Rate (FCR)	2.8 ± 0.35^a	2.8 ± 0.3^a	2.6 ± 0.36^a	2.6 ± 0.25^a
Survival rate (%)	80 ± 18^a	65.8 ± 16.2^c	70 ± 18.9^b	46.25 ± 6.9^d

***Table 1:** Fish performance for the four treatments.*
Figures in the same rows with different superscripts are significantly different ($p < 0.05$).

Parameters	Treatments			
	A M ± SD	B M ± SD	C M ± SD	D M ± SD
Dissolved oxygen DO (mg/L)	6 ± 0.18^a	5.1 ± 0.26^b	4 ± 0.55^c	4 ± 0.28^c
Ammonia NH_3/NH_4^+ (ppm)	0.4 ± 0.03^c	0.7 ± 0.04^c	1.9 ± 0.96^a	1.4 ± 0.65^b
Nitrite NO_2 – (ppm)	0.05 ± 0.04^c	0.4 ± 0.26^b	0.6 ± 0.2^b	1.3 ± 0.25^a
Nitrate NO_3- (ppm)	9 ± 0.57^d	15 ± 2.6^c	18 ± 3.8^b	23 ± 4.35^a
pH	8.4 ± 0.0^a	8.3 ± 0.05^a	8.1 ± 0.05^b	8.1 ± 0.05^b

***Table 2:** Average measurements of water quality parameters.*
Figures in the same rows with different superscripts are significantly different ($p < 0.05$).

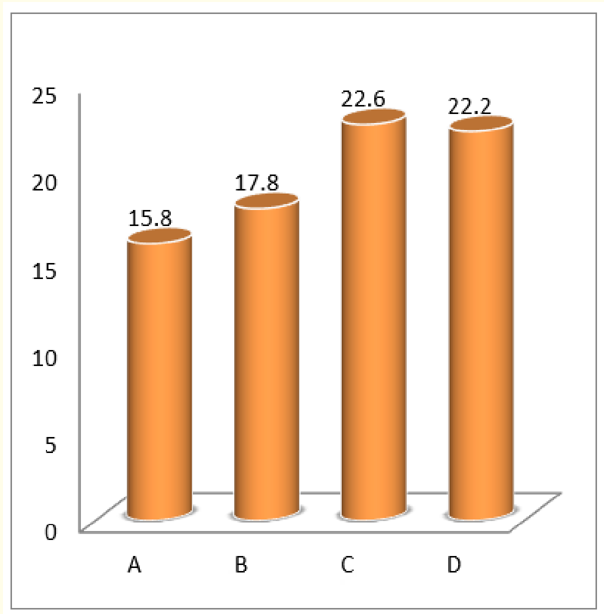

Figure 1: *Weight gain.*

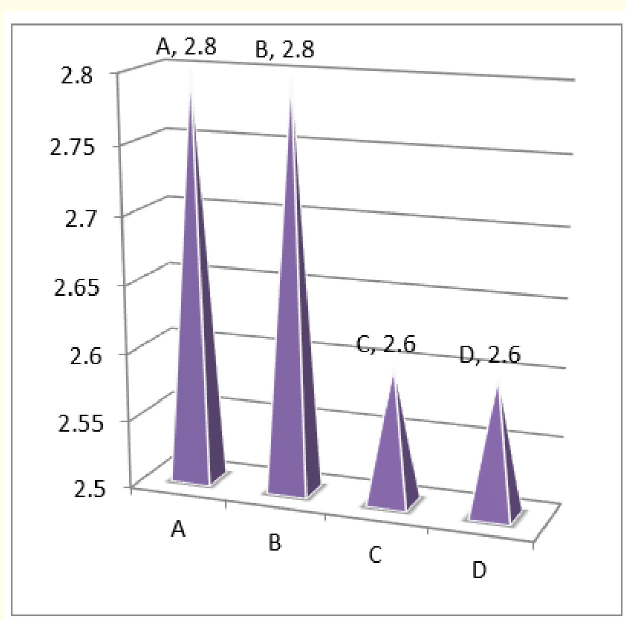

Figure 2: *Food conversion.*

Discussion and Conclusion

Result showed that the percent of weight gain, weight gain, daily growth rate, and specific growth rate were positively proportional with stocking density. While the food conversion rate were affected inversely with stocking density. These completely disagree with a number of authors [4] mentioned high densities can have a negative impact on fish such as low growth, and increased of FCR, this difference is due to the provision of aeration in tanks, and the rate of water exchange (2 times/day) in the culture system used in the present study. Sanudi., *et al*. [5] reported that the mean weight gain and gain in standard length were inversely proportional with stocking density. The fish stocked at a low stocking density grow faster as compared to fish stocked a higher stocking density given the same feed. Likewise, the result of the current study disagree with the findings of study conducted by Rahmatullah., *et al*. [6] to assess the effect of stocking density on the growth performance of fish. Fish were fed with a commercial feed containing 25% protein. positive correlation with stocking density. This agrees with; Yousif [4] who mentioned rearing tilapia fish, especially fry, with high densities in a limited space that leads to what is known as the social hierarchy, where dominant individuals appear and are larger and others subordinate individuals and are smaller in size. The appearance of this phenomenon leads to stress fish that are under the control of larger fish and that prevent them from accessing food, which leads to Poor growth.

Suman., *et al*. [1] reported at the low stocking densities, lack of competition for food and/or social hierarchy can lead to decreased feed utilization efficiency resulting in stunted growth. Mridha., *et al*. [7], Ronald., *et al*. [8] and El-Sayed [3] who have reported a negative correlation between survival rate and stocking density. Datta [9] mentioned decomposition of organic materials (algae, bacteria, and fish wastes) is the single greatest consumer of oxygen in aquaculture systems. increase in the amount of feed input in the treatments (C) and (D)led to an increase in fish waste; this agrees with study done by Al-Harbi and Siddiqui [10] fish growth rate and feed utilization with increasing levels of stocking densities has been observed in several studies [11,12]. Similarly, an increase in net yields with increasing levels of stocking densities has also been recorded [12,13]. In this study the feed consumption rate was found to be affected by the stocking density of fish and decreased with increasing levels of fish density. However, the amount of feed input increased with the increasing density [11].

The feed conversion ratio were recorded to be almost the same for different density treatments. Suresh and Lin [12] have reported similar findings where feed conversion ratios of the individual fish were not significantly. Dissolved oxygen concentrations in tanks of different stocking densities were never recorded below 4 mg/l because the tanks were continuously aerated. For O. niloticus reared under different culture systems, oxygen levels 4 - 8 mg.l have been recommended [14,15]. Siddiqui., *et al*. [16] reported a decrease in DO concentrations with decreasing rates of water exchange in O. niloticus tank culture, whereas no effect of four stocking densities (final biomass 1.3 $kg^{-1}.kg.m^{-3}$) [17]. They found the proportion of NH_3-N to ionized form depends upon the pH and temperature of the water. During this study, NH_3-N values significantly increased as the fish density and feed input increased and average NH_3-N concentrations ranged from 0.4 to 1.9 mg.l. Palachek and Tomasso [18] reported similar in nitrite nitrogen sensitivity [19].

Recommendations

This study recommended the following:

1. Optimum stocking density of fish reared in fiberglass tanks can be (240 fish/m^3).
2. Water quality management must be control in stocking density.

Acknowledgement

we would like to express our deep and sincere gratitude to Dr. Elnouman Babikir (may Allah have mercy on him). Thank for all members of Neelain university.

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Volume 6 Issue 5 May 2021