



Effect of Different Feeding Rates on Growth Performance and Survival Rate of Tilapia (*Oreochromis niloticus* L. 1758) Fingerlings Reared in Rectangular Hapas

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2023/v25i3664

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/105888>

Original Research Article

Received: 01/07/2023

Accepted: 05/09/2023

Published: 14/09/2023

ABSTRACT

The objective of the study was to determine the effect of feeding ration on the growth and survival of *Oreochromis niloticus*. Three experimental hapas (T₁, T₂ and T₃) were studied for a total of 8 weeks. The hapas had a rectangular shape and the same size (0.0725 decimal). In each of the three experimental conditions, 420 fish/decimal were stocked. The fish were fed 8% of their body weight in T₂ and 12% of their body weight in T₃. In T₁, the fish were reliant on food that occurred

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naturally in their environment. In T₂ and T₃, fishes were fed twice daily. The proximate composition of the experimental diet was as follows: 11% water, 30% protein, 6% fat, 10% ash, and 7% fiber. Throughout the trial period, it was determined that the range of water quality parameters (water temperature 28-32°C, dissolved oxygen 5.6-7.8 mg/l, and water pH 7.5-8.6) were suitable for Tilapia culture. The initial mean weight of Tilapia fry in each of the three treatments was 3g, and their final mean weight gain was 6.8±4.77 g for T₁, 9.88±5.76 g for T₂ and 19.2±9.9 g for T₃, respectively. The average initial length for the three treatments was 5 cm, and the average final length gain was 8.2±6.15 cm, 9.86±7.36 cm, and 12.2±8.23 cm for T₁, T₂ and T₃, respectively. The T₃ group, which was fed at a rate of 12% of body weight, attained the highest length and weight, whereas the T₁ group, with no supplemental nutrition revealed the least gain in terms of length and weight.

Keywords: Feeding rate; growth performance; *Oreochromis niloticus*; survival rate.

1. INTRODUCTION

Bangladesh is characterized by its extensive river network, which contributes to the abundant presence of fish in both rivers and other natural water bodies throughout the country. Fish plays a pivotal role in the dietary habits of the Bangladeshi population, serving as a primary source of animal-based sustenance, accounting for about 60% of animal source protein. Currently, the fish consumption in Bangladesh stands at 67.8 gm/day, which exceeds the recommended threshold of 60.0 gm/day for daily animal protein intake [1]. The fish production in the fiscal year 2021-22 yielded to 47.59 lakh MT, representing a significant increase of 55.42% compared to the total production in the fiscal year 2010-11, which recorded at 30.62 lakh MT. During the period of 1983-84, the overall fish production in the country measured to 7.54 lakh MT. Currently, the fisheries sector contributes 1.24% of the export income of the country [1]. Fish is exported to over 50 nations worldwide. During the preceding fiscal year, a total of 74,042.67 MT of fish and fish products were exported, resulting in a revenue of 5191.76 crore BDT. This represents a notable increase of 26.96% compared to the previous year. According to FAO, Bangladesh has been positioned as the 5th leading country globally in terms of aquaculture production [2].

The Nile tilapia (*O. niloticus*) is a species that is extensively cultivated due to its ability to thrive and breed in diverse environmental circumstances, as well as its capacity to withstand stress caused by handling [3]. Currently, it holds the second position in global production, surpassed only by carps. The primary benefit of a monosex culture can be realized in aquaculture scenarios. *O. niloticus* has been recognized as a highly significant fish

species in the field of tropical and sub-tropical aquaculture [4]. The significance of aquaculture is growing fast due to the rise in human population and the depletion of natural fishing supplies. The practice of pond aquaculture is experiencing rapid growth in numerous Asian countries that have limitations in terms of available resources [5]. To ensure the future sustainability of per capita aquatic product supply, it is imperative to expand aquaculture production, as the capacity for expansion in catch fisheries has reached its limit. However, the implementation of small-scale fish culture has frequently encountered challenges stemming from insufficient understanding of optimal feeding rate, stocking density, and feeding frequency for fish [6].

Nevertheless, the concept of feeding frequency typically pertains to the number of times that organisms should be provided with rations within a given day [7]. One of the crucial elements that has a significant impact on fish growth, feed utilization, and overall fish output is widely acknowledged [8]. The optimization of spatial resources to achieve optimal fish production through intense aquaculture has the potential to enhance the economic viability of fish farms [9]. Tilapia has successfully established a stable presence in various water impoundments in Bangladesh, wherein monosex species exhibits significant growth performance [10]. Therefore, the cultivation of monosex Tilapia could potentially be an effective strategy for promoting a favorable attitude towards tilapia farming in Bangladesh. With regards to these factors, the primary objective of this study was to assess the growth performance of monosex tilapia under different feeding rates. Additionally, the study aimed to evaluate the growth performance of the Tilapia population when fed with natural feed, in order to determine the optimal feeding rate for

tilapia culture within the specific climatic and ecological conditions of the study area. The expenditure associated with feed is a significant component of operational costs within the aquaculture industry. Hence, the act of feeding can be seen as a crucial aspect within cultural practices. Previous research has demonstrated that the rate of feeding significantly impacts the digestibility of fish. Overfeeding can result in the leaching of nutrients, while limited feeding can lead to reduced development rates in fish owing to famine.

The primary aim of this study was to determine an appropriate culture method and feeding frequency that would yield optimal growth response in *O. niloticus*, a prominent fish species for aquaculture in Bangladesh. Hence, the standardization of feeding frequency for the specific species in aquaculture is of utmost significance in achieving the intended growth outcomes.

2. METHODS AND MATERIALS

2.1 Study Area and Duration

The experiment was carried out at the Bismillah Agro-Farm and Hatchery under Noakhali District (Fig. 1.). The study period encompassed the time period from October 6th to December 6th, 2017. An experiment over a duration of 8 weeks was done, whereby the primary sources of water

were derived from a pump and rainwater. The average water depth of the water body exceeded 3 feet, with the net of the cage (hapa) positioned to ensure that the water level inside the cage remains consistently above 1.5 feet.

2.2 Experimental Design

This experiment was carried out by constructing three distinct cages (hapas) in the water body using net and native bamboo. Each cage was $8_L \times 4_W \times 4_H$ feet in size. Each cage was kept 100 cm apart from each other, and the same distance was maintained between the embankment and a cage. Three cages were marked as T_1 , T_2 and T_3 , respectively. T_1 included no additional feed, leaving the fish entirely dependent on natural food. In T_2 , 8% of the body weight of the *O. niloticus* was fed, and 12% of the body weight was fed in T_3 (Table 1). In all three treatments, the stocking density was 420 fish/decimal.

2.3 Collection of Fry and Conditioning

The *O. niloticus* fry was collected from Bismillah Agro based farm, Noakhali. The fry was 40 days old. The average length of the fry was 5 cm and weight were 3 g on average. Same length and weight of fry were selected for this study. All fry were healthy and disease free. The fry was conditioned in the Bismillah Agro farm for 3 hours before stoking in the experimental hapas.



Fig. 1. The experimental site [Source: Google Earth]

Table 1. Experimental layout of *O. niloticus*

Treatment	Size of the cage (Dec)	Stocking density/Dec	Number of fish	Fish feed
T-1	0.0725	420	30	No
T-2	0.0725	420	30	8%
T-3	0.0725	420	30	12%

2.4 Stocking of Fish

Following the completion of the preparation process, the *O. niloticus* species was introduced into the hapa enclosure. All fish exhibited uniformity in terms of both size and age. A total of 30 species were introduced for each treatment. The observed species exhibited robust health and was devoid of any pathological conditions. In order to assure the absence of diseases in fish, a salt bath treatment was administered for a duration of three minutes using a 5ppm Epsom Salt Soaking Solution, which consists of Magnesium sulfate ($MgSO_4$).

2.5 Water Quality Parameters

During the study period, various parameters were measured on a weekly basis, including water temperature, dissolved oxygen levels, pH, and the availability of natural food, specifically plankton. The water temperature of the experimental water body was assessed on a weekly basis throughout the duration of the study using a Celsius thermometer. The pH of the water body was monitored once each week. The experiment utilized a digital portable pH meter (Model: HANNA- HI 96107) to conduct the experiment. In order to ascertain the level of dissolved oxygen in the experimental water body, a portable Dissolved Oxygen Meter (Model: Lutron-DO-5509) was employed.

The measurement of dissolved oxygen was conducted on-site, without the need for collecting any water samples for analysis in a laboratory setting.

2.6 Feeding Management

Throughout the duration of the experiment, the floating starter feed with a diameter of 2.6 ± 0.3 mm was employed. Feeding was provided two times daily, one at 10:00 am in the morning and another at 5:00 pm in the afternoon.

In T_1 , no additional feed was provided. In T_2 , feed was provided at a rate equivalent to 8% of the body weight of fish, while in T_3 , feed was provided at a rate equivalent to 12% of the body weight (Fig. 2). The feeding rate was determined by calculating the average weight of Tilapia following each sampling event. The feed was stored in a hermetically sealed polythene bag. The feed was provided directly, without the use of a feeding tray. The dispersion of feed was uniformly achieved across the water surface within the hapa enclosure. The ration was divided into two equal parts, with one half being delivered at 10:00 am and the other half being supplied at 5:00 pm daily.



Fig. 2. The measurement of feeding ration

Table 2. The composition feed used in the experiment

Type of feed	Protein (minimum)	Moisture (maximum)	Fat (minimum)	Fiber (maximum)	Ash (maximum)
Floating starter	30%	11%	6%	7%	10%

2.7 Sampling and Measurement of Length and Weight

Fish were captured using a scoop net from the hapa, and the length and weight of each species were measured and documented. An analogue balance machine was utilized for the purpose of weighing, while a tap was employed to measure length. Measurements of length and weight were collected at regular intervals of 7 days. On the day of sampling, all fish specimens were captured in order to verify whether any fish had escaped or perished. The health status of the fish was observed and recorded during the process of fish sampling. The entirety of the sample procedure was conducted with great care, given the high susceptibility of the little fry to stress induced by handling. During the process of sampling, a concerted effort was made to minimize the sampling error.

2.8 Study of Growth Parameters of Fish

For evaluating the growth of fish, different growth parameters such as length gain (cm), weight gain (g), specific growth rate (SGR % per day) and production (kg/ha) were taken into consideration and were measured using the following formula:

$$\text{Weight gain (gm)} = \text{Mean final weight (gm)} - \text{Mean initial weight (gm)}$$

$$\text{Production} = \text{No. of fishes harvested} \times \text{average final weight increase of fishes}$$

$$\text{Survival rate} = \frac{\text{No. of fish harvested}}{\text{No. of fish stocked}} \times 100$$

$$\text{FCR} = \frac{\text{Amount of feed given by dry weight}}{\text{Final live weight gain by the fish}}$$

2.9 Statistical Analysis

The data acquired from the experiment regarding growth performance, weight gain, length increase, survival rate, and production were subjected to statistical analysis in order to determine the significance of the influence of various treatments (specifically feed) on these parameters. The use of several statistical techniques was facilitated through the employment of Microsoft Excel (version 2017), a statistical software program.

3. RESULTS

3.1 Water Quality Parameters

The monitoring of water quality parameters was conducted diligently throughout the entire duration of the experiment. Throughout the entire study period, the parameters such as temperature, pH levels, dissolved oxygen concentrations, and water transparency were recorded accordingly. The observed parameters of temperature, pH, dissolved oxygen, and transparency exhibited variability, with temperature, pH, and dissolved oxygen displaying fluctuations, while transparency remained relatively consistent. The comprehensive representation of the water quality parameters for the experimental water body can be observed in Table 3.

Table 3. Water quality parameter

Treatment	Parameter	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8 th week
T ₁	pH	8.0	8.5	7.5	7.0	8.4	7.9	7.5	7.8
	DO (mg/l)	7.0	6.3	6.8	7.1	6.4	6.9	6	6.6
	Temperature(°C)	30	32	29	28	30	29	30	31
T ₂	pH	8.0	7.5	7.0	7.8	8.0	7.5	8.5	7.9
	DO (mg/l)	7.0	7.5	7.0	7.4	6.0	6.5	7.4	6.0
	Temperature(°C)	30	29	31	28	30	32	30	29
T ₃	pH	7.8	8.4	7.0	6.5	7.8	7.5	7.0	7.5
	DO (mg/l)	5.8	6.5	6.4	7.6	6.5	7.6	7.3	6.0
	Temperature(°C)	28	30	32	29	30	32	31	32

During the study period, the pH of the controlled water body was evaluated on a weekly basis. The pH value that was discovered to be the highest was 8.6 in the 2nd week of T₁, and the pH value that was found to be the lowest was 7.5 in the 2nd week. During the course of the research, the pH level that was most typical for T₁ was 8.13 (Fig. 3.).

The maximum recorded water temperature was 32°C during the second week in T₁ and T₃, and during the 6th and 8th weeks in T₂ and T₃, respectively. The lowest temperature of 28 °C was observed during the 2nd week of T₁, the 4th week of T₂, and the 1st week of T₃. In T₃, the

reported average peak temperature was 30.37 °C (Fig. 4.).

The measurement of dissolved oxygen was conducted at 7 days intervals throughout the study period. The highest dissolved oxygen (DO) concentration was recorded as 7.6 mg/L in T₂. The minimum dissolved oxygen concentration of 5.6 mg/L was observed in T₁ during the 8th week. It was observed that the average dissolved oxygen (DO) level was initially higher at the commencement of the study period. However, as the study period progressed, there was a reduction in the DO level across all three treatments (Fig. 5.).

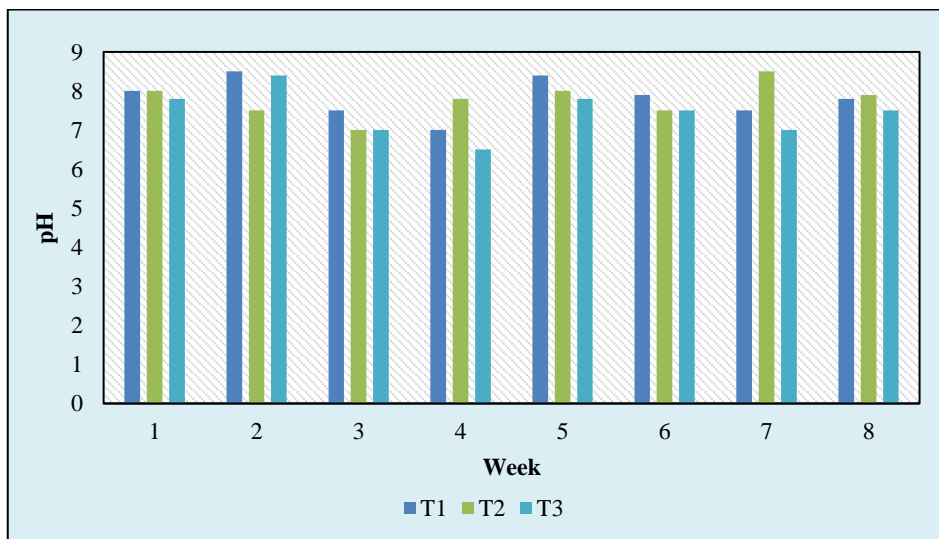


Fig. 3. Variation of water pH during the study period

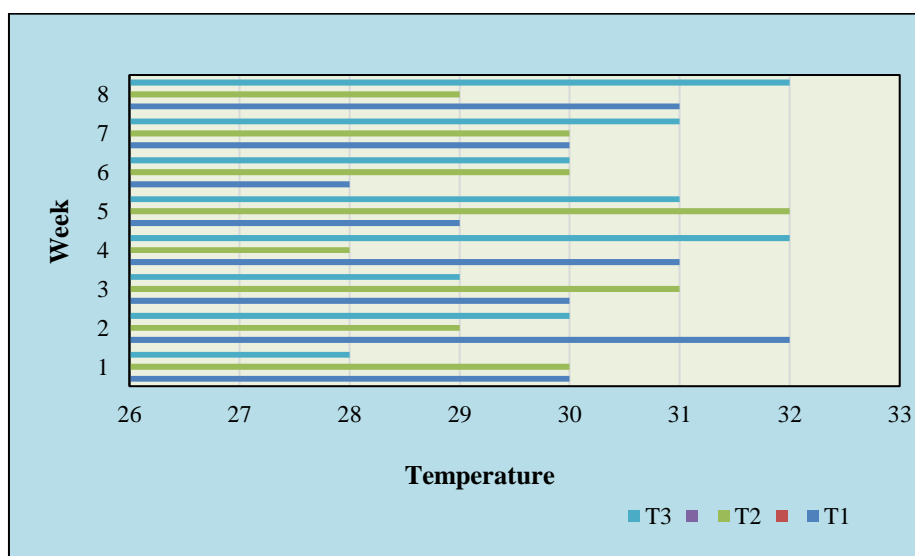


Fig. 4. Variation of water temperature during study period

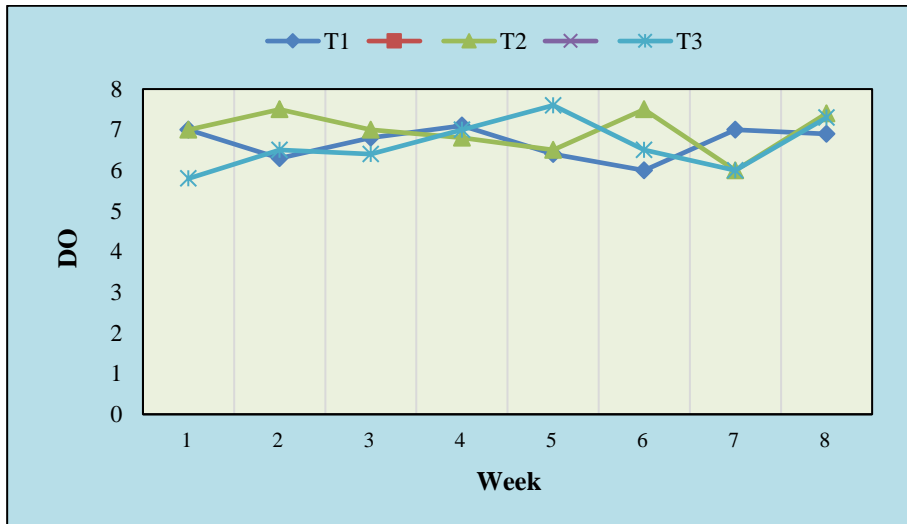


Fig. 5. Variation of water DO during study period

3.2 Growth Performance of *O. niloticus*

The weight and length gain of Tilapia were used to calculate their growth performance under various treatments. The final weight gain (g), mean weight gain (g), average daily weight gain (g), percent weight gain (g), and species survival rate have all been used to evaluate *O. niloticus*'s growth performance across all treatments.

3.3 Weight Performance

The determination of the average total weight was achieved through the utilization of a precision weight measuring apparatus. The mean initial weight of the fish in all treatments was recorded to be 5 gm. The sampling

procedure employed a random selection method, ensuring unbiased representation. Consequently, the weight of *O. niloticus* exhibited variability across the various treatment groups. The observed trend in the data reveals a consistent increase in the weight of all fish over the designated time interval, spanning from the initial week to the 8th week. Upon conclusion of the experimental study, it was observed that the average weight of *O. niloticus* in T₃ was determined to be 19.2±9.9 gm. Similarly, in T₂, the weight was recorded as 9.35±5.76 gm, while in T₁, the average weight was found to be 6.8±4.77 gm. The observed weight gain of T₃ exhibited both higher and lower values compared to T₁ (Fig. 6.).

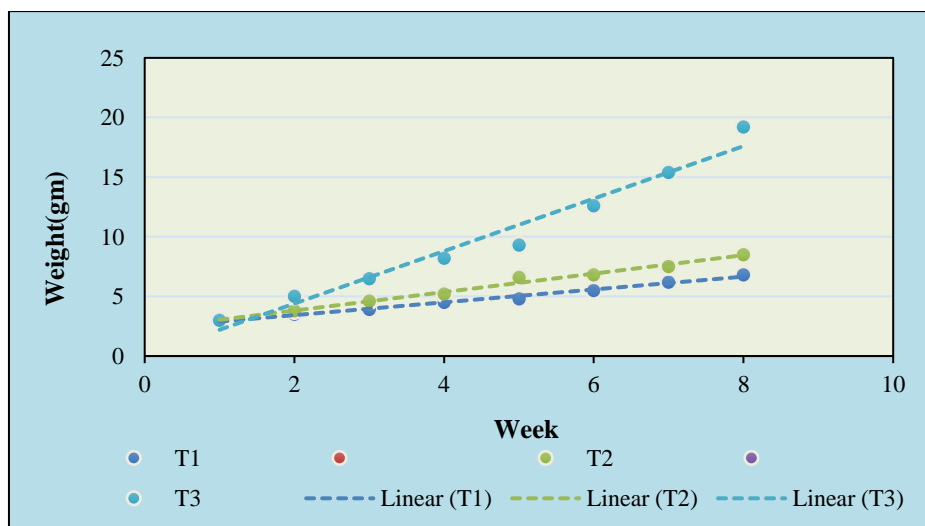


Fig. 6. Weight performance of Tilapia fry in different treatments

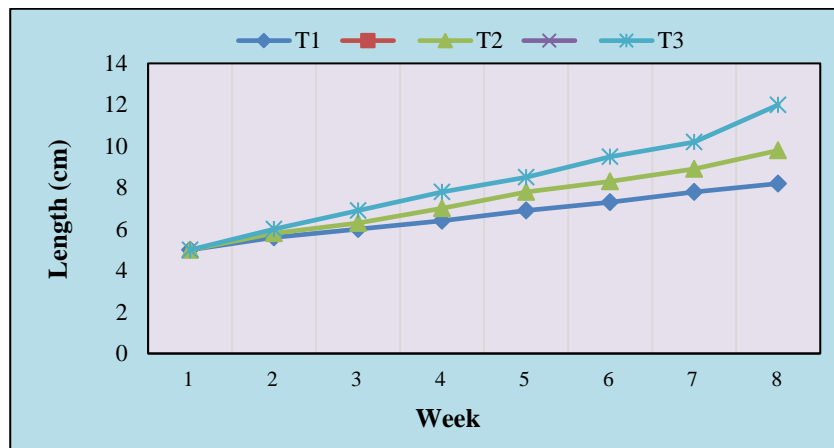


Fig. 7. Length performance of *O. niloticus* fry in different treatment

3.4 Observation of Length Performance

The initial length of all fishes was 8 cm. In order to assess the length of *O. niloticus*, a random sampling approach was employed, resulting in the identification of length variability across three different treatments. The length of all fishes has shown an increase over the given time interval. Upon completion of the experiment, it was observed that the average length of *O. niloticus* in T₁, T₂, and T₃ was (8.2±6.15) cm, (9.8±7.36) cm, and (12±8.23) cm, respectively. The observed trend in T₃ indicated a remarkable increase in length. The observed trend indicates that the average increase in length was highest in treatment T₃ compared to the other treatments. Conversely, it was observed that the lowest increase in length occurred in T₁ (Fig. 7).

3.5 Weight gain of *O. niloticus*

The study period involved the observation of weight gain in *O. niloticus* fish fry across different treatments. The weight gain varied on a weekly basis. The final average weights recorded in T₁, T₂, and T₃ were 4.77 g, 6.4 g, and 10.3 g, respectively. In T₁, the rate of weight increase remained rather consistent over each week. The mean weight gain in T₁ was 0.677 g with a standard deviation of 0.40 g. The maximum weight gain was observed in the 4th week (1.5 g) in T₂, while the lowest weight gain was recorded in the 1st week (0.8 g). The average weight gain observed in this treatment was 1.05±0.80 g. In T₃, the maximum weight gain was observed during the 8th week, with a value of 3 g, while the minimum weight gain was documented during the 5th week, with a value of 1.1 g. The mean weight gain perceived in T₃ (1.97±1.12 g), as depicted in Fig. 8.

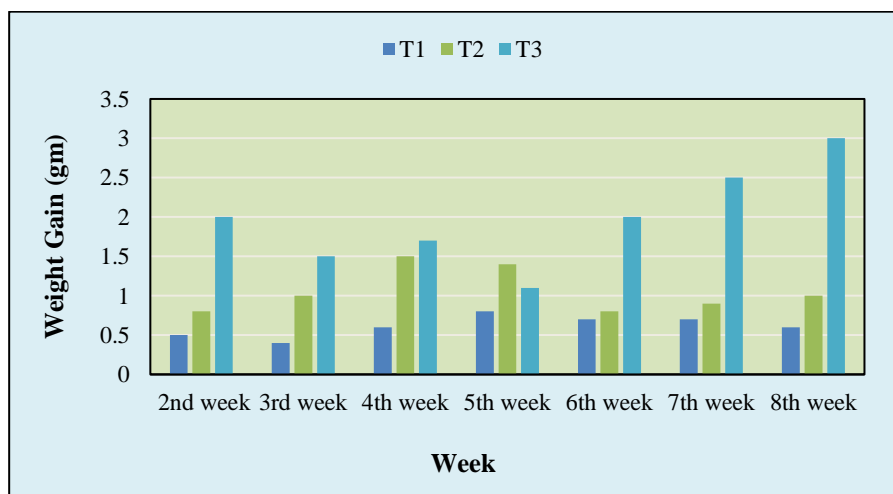


Fig. 8. Variation in weight gain of *O. niloticus* in different treatment

3.6 Length Gain of *Oreochromis niloticus*

The final average length gains observed in T₁, T₂, and T₃ were 6.55 cm, 8.54 cm, and 10.4 cm, respectively. The study observed that the highest length gain occurred during the 2nd week of T₁, measuring 0.6 cm. Conversely, the lowest gains in length were observed during the 8th and 3rd weeks, both measuring 0.4 cm. The average length gain observed in T₁ (0.454±0.26 cm). In the T₂, the maximum increase in length was observed during the 8th week, measuring 0.9 cm, while the least increase was recorded during the 3rd week, measuring 0.5 cm. The study determined that the mean length increase of T₂ (0.685±0.69 cm). The highest growth was observed during the 8th week in T₃, measuring

1.5 cm, while the lowest growth occurred during the 5th week, measuring 0.7 cm. The observed mean length gain was 0.967±0.62 cm (Fig. 9).

3.7 Survival Rate

The study revealed that the T₃ group exhibited the highest survival rate, which was determined to be 96%. The survival rate in T₁ was observed to be the lowest, with a recorded value of 90%. The survival rate in T₂ was 93%. The observed disparity in survival rates can be attributed to variations in environmental conditions, as well as differences in feeding % and feed utilization (Fig.10).

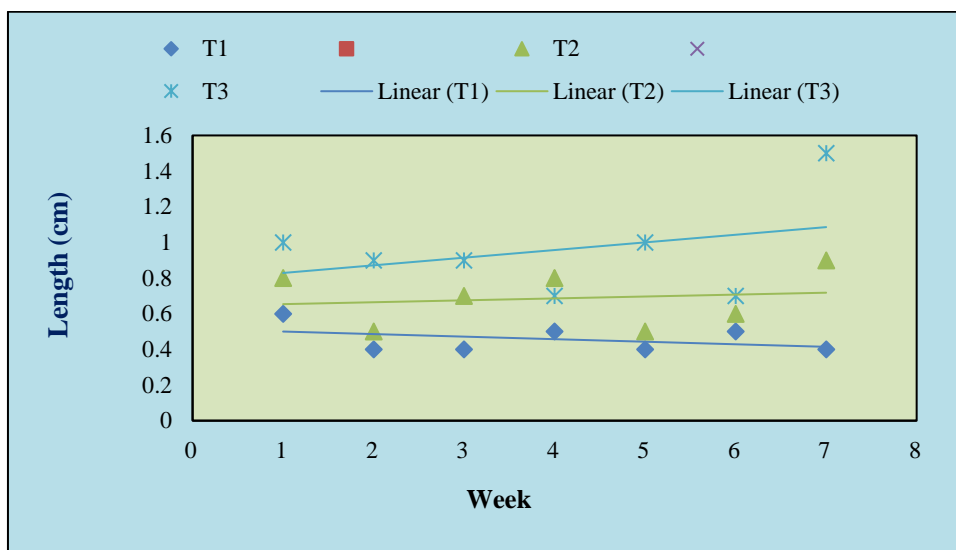


Fig. 9. Variation in length gain in different treatment

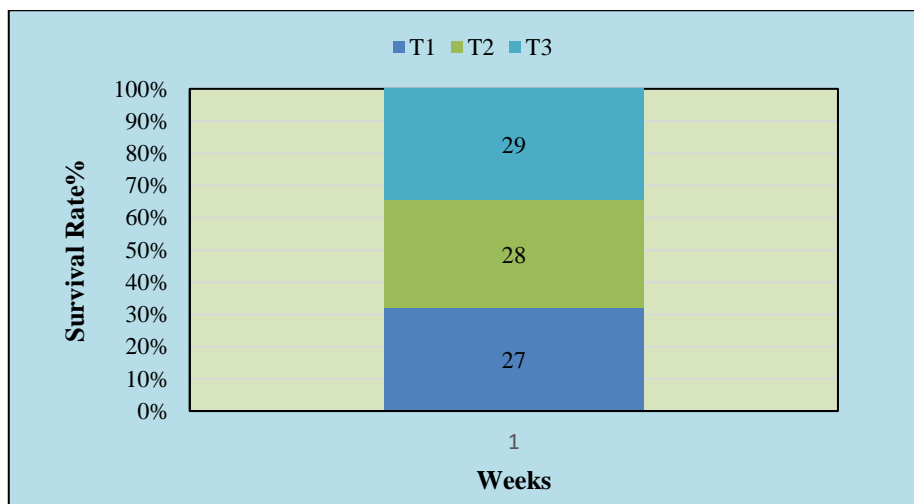


Fig. 10. Survival rate of fry in different treatment

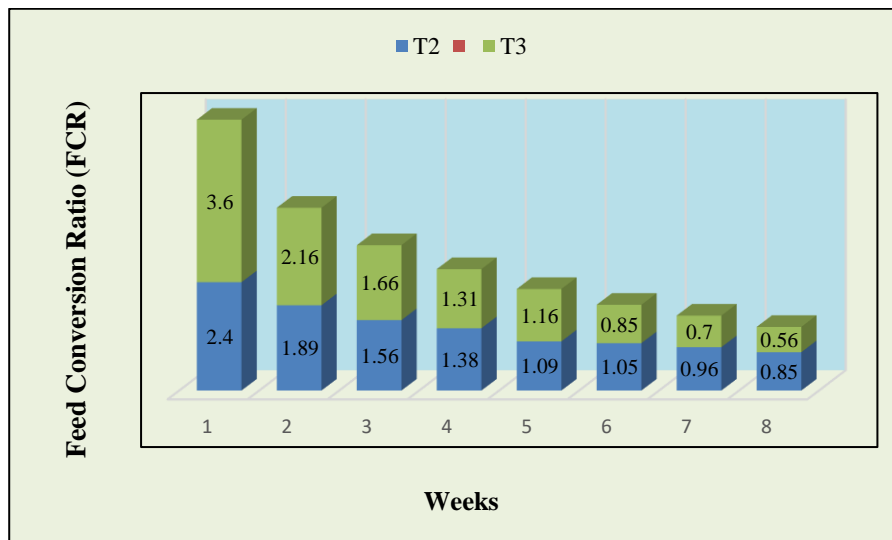


Fig. 11. Variation of FCR in different treatment

3.8 Observation of FCR

The FCR (Feed Conversion Ratio) for the two experimental treatments (T_2 and T_3) was computed subsequent to the completion of the study. The feed conversion ratio (FCR) in T_2 was determined to be 2.4, while in T_3 , the FCR was measured to be 3.6. In T_1 , no feed was supplied this is why FCR was not applicable for that treatment (Fig. 11).

4. DISCUSSION

4.1 Weight Performance of Tilapia

In each of the three treatments, the initial mean weight was 3 g. At the end of the study, *O. niloticus* had mean weights of 6.8 ± 4.77 g, 9.35 ± 5.76 g, and 19.2 ± 9.9 g in T_1 , T_2 and T_3 , respectively. At the end of the trial, T_3 had the largest mean weight gain. At harvest, T_3 had the highest average weight of Tilapia fry (19.2 ± 9.9 g), followed by T_2 (8.5 ± 5.76 g) and T_1 (6.8 ± 4.77 g). *O. niloticus* showed the highest weight gain in T_3 , when feed was administered based on the 12% body weight of the fishes. Binh et al. [11] conducted an experiment in a metal cage with *O. niloticus* and observed the comparable outcomes by providing a prepared diet with locally available ingredients and used daily at a rate that dropped from 15% to 3% of their body weight. For a culture period of 6 months, Hussain et al. [12] and Hasan et al. [13] observed that Tilapia in on-farm ponds fed rice bran at 5-6% of their body weight gained approximately 128 g of weight.

Tilapia in this study fared better in terms of weight gain, taking into account the 8-week culture time, as opposed to the 6-month period by [12].

4.2 Length Gain

The average initial length of fish fry in all three treatments was 5 cm. At the end of the study, the average length of Tilapia was found to be 8.2 ± 6.65 cm, 9.8 ± 7.36 cm and 12 ± 8.23 cm in T_1 , T_2 , and T_3 , respectively. The experimental results revealed that the fry in T_3 group had the highest mean length. The average length of Tilapia fry varied among the different treatments. Treatment T_3 had the highest mean length of 12 cm, followed by T_2 with a mean length of 9.8 cm, and T_1 with a mean length of 8.2 cm. Olurin and Aderibigbe (2014) conducted a study in which they observed a 100 juvenile of *O. niloticus* and observed the length of the fish ranged from 5.5 to 11.4 cm. In the current study, it was observed that the maximum mean length was recorded in T_3 (11.38), a finding that closely aligns with the results reported by [14].

4.3 Survival Rate (%)

The recorded mean survival rates of *O. niloticus* in all three treatments were 93%. In this study, enhanced survival rates were observed in the fish population, as they demonstrated the ability to endure challenging environmental circumstances such as low oxygen levels, high temperatures, and elevated pH levels. The findings of the current study closely aligned with

the research conducted by [15], which reported that the survival rates of Koi (*Anabas testudineus*) ranged from 60%-80%. The findings of this study are consistent with the findings of Kohinoor [16] regarding T₁ and T₃, which indicated that the survival rates of *O. niloticus* ranged from 79%-92%.

4.4 Feed Conversion Ratio (FCR)

The feed conversion ratio (FCR) values for Tilapia fry fed with the commercial feed were recorded as 3.60 and 2.40 in T₁ and T₂, respectively. A lower feed conversion ratio (FCR) value of 2.40 was observed in T₂, when supplementary feed was provided at a rate equivalent to 8% of the body weight. According to the study conducted by Ahmed et al. (2013), the Food Conversion Ratio (FCR) in Tilapia was seen to be 1.51 and 1.40 in the homemade and commercial feed, respectively. Hossain et al. [17] reported that the feed conversion ratio (FCR) value for the formulated diet ranged from 1.71-1.77, which exhibited slight variation compared to the findings of the current investigation. The observed variation may be attributed to disparities in temperature, geographical location, and management practices. In the current investigation, the moisture content was determined to be 11%, which may potentially contribute to the observed higher feed conversion ratio (FCR) value. According to Cruz and Laudencia [18], fingerlings require a diet containing 20-30% crude protein in order to achieve optimal outcomes in pond environments. The feed utilized in T₂ and T₃ in the current study exhibited comparable levels of crude protein. The observed variation in feed conversion ratio (FCR) cannot be attributed to the protein content in the diet.

4.5 Water Quality Parameters

The temperature plays a significant role in influencing the growth, reproduction, survival, and various other physiological functions of fish. According to Clarke [19], there is a positive correlation between temperature and metabolic rates in organisms. Clarke [20] demonstrated once more that perciform fish lack the physiological adaptations necessary to cope with cold environments. Hence, it can be observed that temperature exerts a significant influence on the overall productivity of fish. In the current investigation, the water temperatures ranged from 28°C to 32°C. According to Azaza et al.

[21], it has been hypothesized that the growth and feed utilization of juvenile *O. niloticus* may exhibit higher rates when reared at temperatures of 26 and 30°C. In the current investigation, the temperature range observed exceeded that of Azaza. In contrast, Ridha [22] documented that the optimal temperature range for feeding was found to be between 28.8-31.4°C. Notably, the highest growth rate was observed at 31.4°C, resulting in an average body weight gain of 3.42% over a 24-hour period. The temperature range observed in this study is comparable to that of the present investigation. In a study conducted by Ridha [22], it was demonstrated that maintaining a water temperature of 29.0±1.0°C resulted in a significant growth response ($p < 0.5$) in *O. niloticus*.

The level of dissolved oxygen in a water body is a crucial component that significantly impacts the cultivation of fish. In the current study, the concentration of dissolved oxygen ranged from 5.8-7.40 mg/l. The Department of Fisheries (DoF) [23] has indicated that the optimal dissolved oxygen (DO) range for fish cultivation is between 5.0-8.0 ppm. The dissolved oxygen (DO) level observed in the current investigation differs from that reported in the Department of Fisheries (DoF) report. The variation in aquatic ecosystems can be attributed to factors such as environmental conditions, the type of water body, and geographic location. In their study, Mollah and Haque [24] documented that the average dissolved oxygen (DO) level in two ponds located within the BAU Campus ranged from 1.19-7.74 mg/l. The results of the current investigation exhibit similarities with the aforementioned studies.

The pH level of water in this investigation ranged from 7.4-8.5. Based on the findings of reference [23], it has been determined that the ideal pH range lies between 6.5 and 8.5. The current study has determined that the pH level is within the optimal range. Additionally, it has been noted by [25] that a pH level between 6.5 and 8.0 is considered suitable for the purposes of culturing. According to a study conducted by [24], a pH range of 5.66-7.66 has been identified as optimal for fish culture. In contrast to the findings of the study referenced as [24], the pH level observed in the current study was slightly high. The aforementioned factors contributing to this phenomenon include various environmental conditions, geographical positioning, and additional operational considerations.

5. CONCLUSION

Due to its rapid development and affordable price *O. niloticus* is well-liked and encourages fish producers around the country to cultivate this species. Farmers must use supplementary feed in order to achieve a profit in a short culture period. The supplemental feed in aquaculture should ensure that there is a minimum amount of feed waste because feed makes up a large portion of the overall budget and inadequate feeding rates can result in growth that is below target. Fish farmers should therefore be well-versed in the precise feed requirements of fish. Different treatments displayed varying growth rates under the experimental circumstances. The mean final weight gain was 6.8 ± 4.77 g for treatment T₁, 9.88 ± 5.76 g for treatment T₂, and 19.2 ± 9.9 g for treatment T₃, respectively. The final length gain was 8.2 ± 6.15 cm, 9.86 ± 7.36 cm, and 12 ± 8.23 cm in T₁, T₂, and T₃, respectively. In this study, T₃ had the largest average weight growth, which may have been caused by a different feeding rate. Based on the current experimental conditions, the optimal feeding rate for tilapia in hapa condition is 12% of their body weight, as opposed to 8%, and natural food alone is insufficient for profitable growth.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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