

Original Research Article

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

Abstract

The purpose of the study was to determine the impact of feeding ration on the growth and survival rate of *Oreochromis niloticus*. Three experimental hapas (T₁, T₂, and T₃) were used in the study for a total of 8 weeks. The hapas had a rectangular shape and were of the same size (0.0725 decimal). For the experiment, 420 fish/decimal were stocked in each of the three treatments. The fish were dependent on naturally occurring feed in T₁ and were fed at a rate of 8% of body weight in T₂ and 12% of body weight in T₃. In T₂ and T₃, feeding frequency was twice daily. The proximate composition of the experimental diet was as follows: moisture 11%, protein 30%, fat 6%, ash 10%, and fiber 7% (% dry matter basis). During the trial period, it was determined that the range of water quality parameters (water temperature 28 to 32°C, dissolved oxygen 5.6 to 7.8 mg/l, and water pH 7.5 to 8.6) were found suitable for Tilapia culture. The mean initial weight of tilapia fry in each of the three treatments was 3g, and 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 average initial length in the three treatments was 5 cm, while 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. 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 feeding revealed the least gain in terms of length and weight.

Keywords: Feeding Rate, Growth performance, *Oreochromis niloticus*, Survival rate

Introduction

Bangladesh is a land of river and fish are very much abundant in rivers and other natural water body. Fish plays a crucial role in the Bangladeshi diet, providing more than 60% of animal source food. At present, fish consumption of Bangladesh is 67.8 gm/day against the set target of 60.0

gm/day of daily animal protein intake of its people [1]. In 2021-22, fish production was 47.59 lakh MT; Which is 55.42% more than the total production of 2010-11 fiscal year (30.62 lakh MT). In 1983-84 the total production of fish in the country was 7.54 lakh MT. At present, 1.24% of the export income of the countries comes from the fisheries sector [1]. Fish is exported to more than 50 countries in the world. In the last fiscal year, 74042.67 MT of fish and fish products have been exported earning 5191.76 crore BDT, which is 26.96% more than the previous year. Bangladesh ranked 5th as aquaculture producing country in the world [2].

The Nile tilapia, *O. niloticus* is a widely cultured species because it grows and reproduces in a wide range of environmental conditions and tolerates stress induced by handling [3]. It is currently ranked second only to carps in global production. The predominant advantage of monosex culture can be achieved in such aquaculture situations. *O. niloticus* has been considered as one of the most important species of fish in tropical & sub-tropical aquaculture [4]. With increase in human population and diminished natural fisheries resources, aquaculture is rapidly gaining importance. Pond aquaculture is growing fast in many resource-constrained Asian countries [5]. In order to maintain the present per capita supply of aquatic products in the future, further growth of aquaculture production is needed as the supply through capture fisheries cannot grow any more. But, fish culture on a small-scale basis has often failed due to inadequate knowledge regarding ideal feeding rate, stocking density and feeding frequency of fish [6].

However, feeding frequency is generally used to refer how many times the organisms should be fed in a day [7]. It is considered to be one of the important factors that affect fish growth, feed utilization and gross fish yield [8]. The full utilization of space for maximum fish production through intensive culture can improve the profitability of the fish farm [9]. Tilapia has established a secure position in a number of water impoundments of Bangladesh, where one sex displays remarkable growth superiority [10]. Thus, culture of monosex tilapia might prove effective to induce a positive approach towards tilapia culture in Bangladesh. Considering these aspects, the present study aims to evaluate the growth performance of the all-male monosex tilapia population at various feeding rate and also to evaluate growth performance on natural feed to determine an ideal feeding rate for tilapia culture under this climatic and ecological conditions. Feed cost is one of the largest operational costs in aquaculture. Therefore, the act of feeding may be pointed as one of the most important elements in the culture practice. It is evident from the earlier studies that, rate of feeding plays a vital effect on the digestibility of fish, as excess feeding may lead to leaching of nutrients and limited feeding may reduce the growth rate of fish due to starvation. The main objective of the study was to establish a suitable culture method and feeding frequency in

which the growth of a major fish species for aquaculture in Bangladesh *O. niloticus* response best. Therefore, it is important to standardize the feeding frequency for the target species in aquaculture for desired growth.

Methods & Materials

Study Area and duration

The experiment was conducted in the Bismillah Agro-Farm and Hatchery (Fig.1). The study period was conducted between 06th October to 06th December, 2017. An 8-week experiment was conducted in pond where main source of water was pump and rain water. The water depth of the water body was more than 3 feet on average, where net of the cage (hapa) was set in a manner that it maintains minimum of water level always higher than 1.5 feet inside the cage.

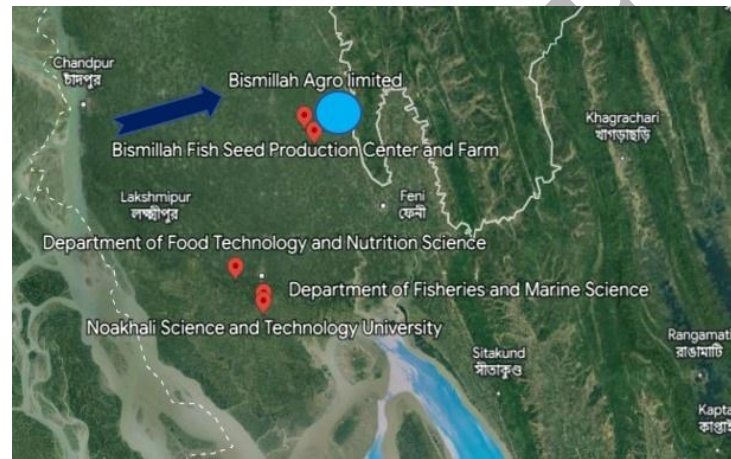


Fig. 1: The experimental site [Source: Google Earth]

Experimental design

This experiment was conducted by establishing 3 different cages in the water body using net and local bamboo. The size of each cage was $8_L \times 4_W \times 4_H$ feet. Distance of each cage from its neighboring one was maintained 100 cm. and same distance was maintained between the embankment and a cage. Three cages were marked as treatment-1 (T_1), treatment-2 (T_2) and treatment-3 (T_3). In the treatment of T_1 , no supplementary feed was given and fish was completely dependent on natural food. In T_2 , feed was given by 8% of the body weight of the *O. niloticus* and in T_3 feed was given 12% of the body weight (Table. 1). Stocking density was 420 fish/decimal in all three treatments.

Table 01: Experimental layout of *Oreochromis 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%

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 hapa.

Stocking of fish

After preparation of hapa fry (*O. niloticus*) was stocked into the hapa. All fishes were similar in size and age. For every treatment 30 species were stocked. This species was healthy and disease free. We use salt bath treatment for 3 minutes in 5ppm Epsom Salt Soaking Solution (Magnesium sulfate) before stocking to ensure disease free fish.

Water quality parameters

In the study period, water temperature, Dissolve oxygen, pH, abundance of natural food (plankton) was recorded one times per week respectively. Water temperature of the experimental water body was measured using a mercury Celsius thermometer one time in a week during the study period. During the study period we measured temperature of the experimental water body at the same time one day in a week. pH of the water body was measured one times in a week during the study period. For this operation a digital portable pH meter (Model: HANNA- HI 96107) were used. To determine the dissolve oxygen of the experimental water body a portable DO meter (Model: Lutron-DO-5509) was used and DO was measured in the spot without collecting any water sample in the laboratory.

Feeding management

In this experiment floating starter feed (diameter: 2.6 ± 0.3 mm) is used throughout the experimental period. Feed was given two times daily at 10:00 am in the morning and 5:00 pm in the afternoon. The composition of the feed is given bellow.

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%

For T₁, no supplementary feed was supplied, T₂ feed were supplied according to 8% of the body weight of the fish and for T₃ feed were supplied according to 12% of the body weight of the fish (Fig. 2). Feeding rate was calculated from the average weight of tilapia after each sampling. Feed was kept in air tight polythene bag. Feed was supplied directly without any feeding tray. Feed was distributed evenly over the surface of the water inside the hapa. Half of the ration was supplied at 10:00 am and remaining half was supplied at 5:00 pm everyday respectively.



Fig.2: The measurement of feeding ration

Sampling and measurement of length & weight

Fishes were caught by using a scoop net from the hapa and measured the length and weight of each species and data were recorded. For weighing an analogue balance machine was used and for length a tap was used. Data on length and weight were taken every 7 days interval. During sampling day all fishes were caught to confirm that if any fish have escaped or died. Health condition were monitored during the sampling of fishes. The total sampling process were handled very carefully as the small fry are very susceptible to handling stress. During sampling we tried to minimize the sampling error carefully.

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/100 days) were taken into consideration and were measured using the following formula:

Weight gain (gm) = Mean final weight (gm) – Mean initial weight (gm)

Production = No. of fishes harvested × average final weight increase of fishes

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

FCR = (Amount of feed given by dry weight) / (Final live weight gain by the fish).

Statistical analysis

Data that are obtained from the experiment on growth performance, weight gain, increase in length, survival rate and production were statistically analyzed to see whether the influence of different treatments (feed) on these parameters were significant or not. This was done by using different statistical method by the help of statistical software named Microsoft excel (version 2016).

Results

Water quality parameters

Water quality parameters of this experiment were monitored throughout the experimental period. Temperature, pH, dissolve oxygen and transparency were observed during the whole study period. Temperature, pH and dissolve oxygen were found variable and transparency was found almost similar. All water quality parameter of the experimental water body is represented in the Table 03.

Table 3: water quality parameter

Treatment	Parameter	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week
	pH	8.0	8.5	7.5	7.0	8.4	7.9	7.5	7.8

T ₁	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

The pH of the experimental water body was measured in every 7 days interval during the study period. The highest pH value was found 8.6^{2nd} week in T₁, and the lowest value of pH was found 7.5 in 2nd week. Average pH was highest in T₁ during the study period and it was 8.13 (Fig. 3).

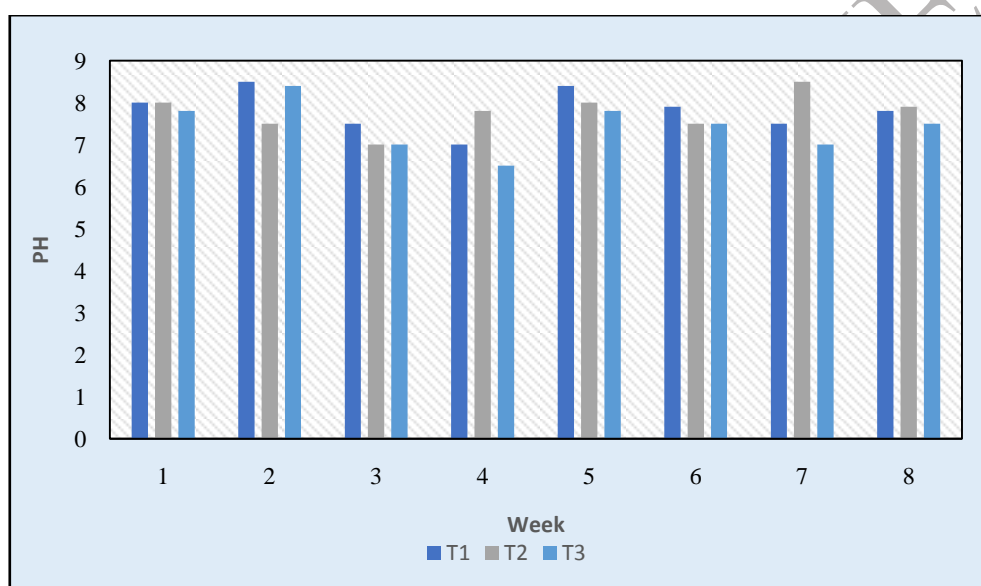


Fig. 3: Variation of water pH during the study period

Temperature of the water was found highest 32°C in 2nd week in T₁ and T₃ and in 6th and 8th week in T₂ and T₃, respectively. The lowest temperature is recorded 28 °C in T₁ 2nd week and T₂ in 4th week and T₃ 1st week. The average highest temperature was recorded 30.37 °C in T₃ (Fig. 4).

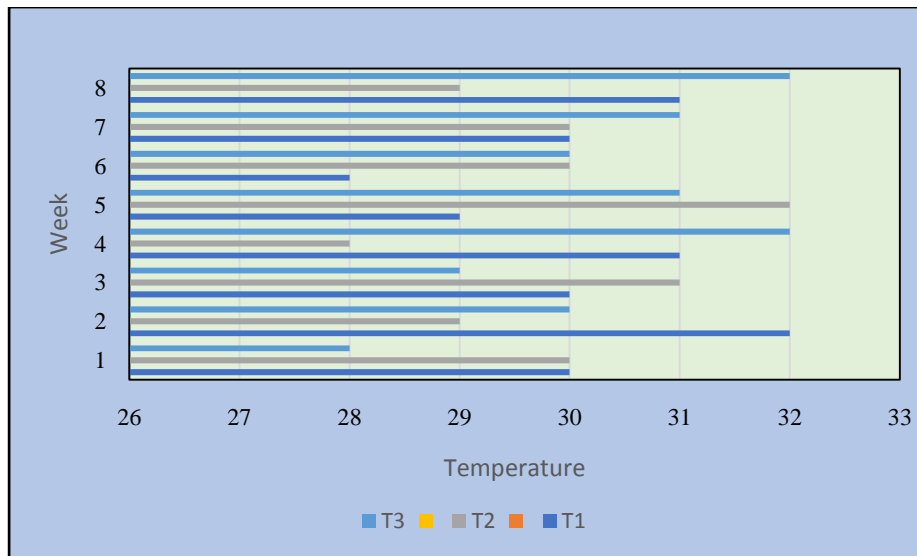


Fig. 4: Variation of water temperature during study period

Dissolve Oxygen was measured during the study period in every seven days interval. Highest DO was found 7.6 mg/l in T2. Lowest value of dissolve oxygen was recorded 5.6 mg/l in T1 in 8th week. From the figure we observe that the average DO level was higher at the beginning of the study period but the level of DO was decrease with the increase of the study period in all three treatments (Fig. 5).

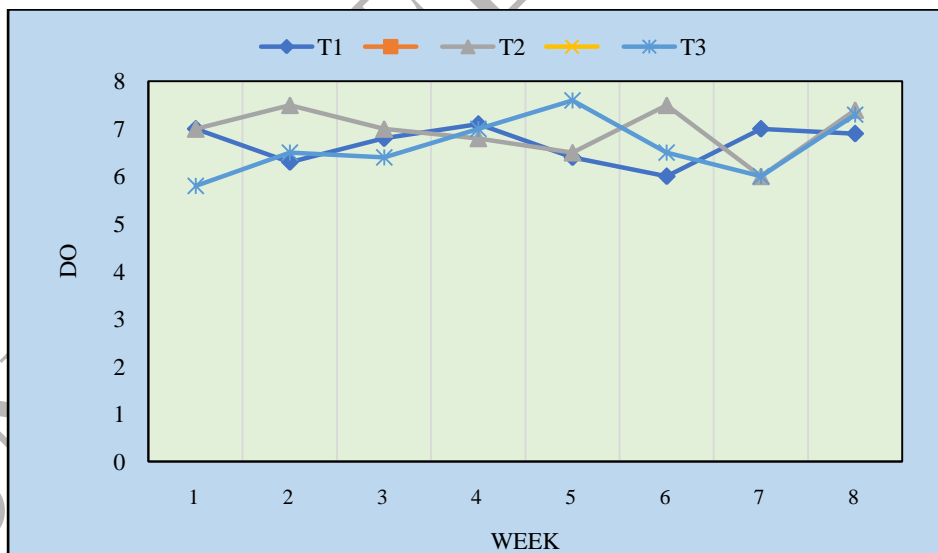


Fig. 5: Variation of water DO during study period

Growth performance of O. niloticus

Growth performance of Tilapia in different treatment was calculated by weight gain and increase in length. The evaluation of growth performance of *O. niloticus* in all treatment has been done in

term of final weight gain (g), mean weight gain (g), average daily weight gain (g), percent weight gain (g), and survival rate of the species.

Weight performance

Average total weight was calculated by using weight machine. The average initial weight of fish as in all treatments were 5g. Sampling was done randomly and found the weight of *O. niloticus* variable in different treatment. Weight of all fish increased with the time interval (from 1st week to 8th week). At the end of the experiment, average weight of *O. niloticus* in T₃ was found (19.2±9.9) gm, in T₂ weight was found (9.35±5.76) gm, in T₁ average weight was found (6.8±4.77) gm. The average weight gain of T₃ was found higher and lower in T₁ (Fig. 6).

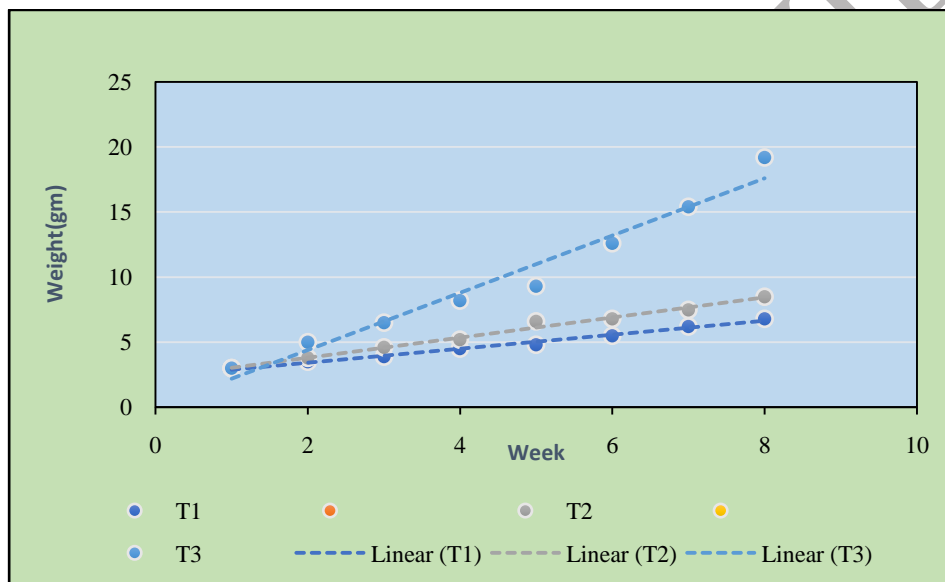


Fig. 6: Weight performance of Tilapia fry in different treatments

Observation of length performance

Average total length was calculated by using a scale. Average Initial length of all fishes were 8 cm. For measurement of length of *Oreochromis niloticus*, random sampling was done and found the length variable in three treatments. Length of all fishes increased with the time interval. At the end of the experiment, average length of *Oreochromis niloticus* was found (8.2±6.15) cm, (9.8±7.36) cm and (12±8.23) cm in T₁, T₂ and T₃, respectively. Increase in length was notable in T₃. Average increase in length was highest in T₃ than other three treatment. On the other hand, increase in length was found lowest in T₁ (Fig. 7).

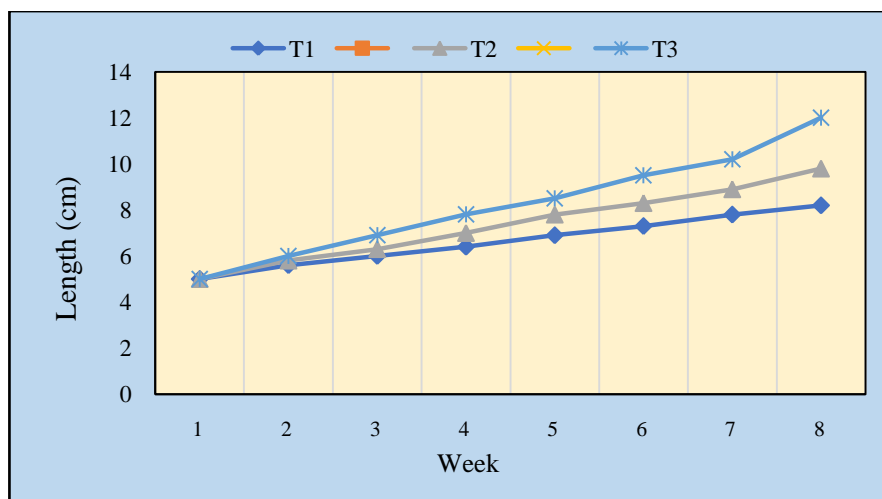


Fig. 7: Length performance of *Oreochromis niloticus* fry in different treatment

Weight gain of Oreochromis niloticus

Weight gain of *Oreochromis niloticus* fish fry was observed during the study period in each treatment. In each week weight gain was different. Final average weight was found 4.77g, 6.4g and 10.3g in T₁, T₂ and T₃, respectively. In T₁ weight gain was almost similar in every week. The average weight gain in T₁ was (0.677 ± 0.40) gm. In T₂ highest weight gain was recorded in 4th week (1.5 gm) and lowest was found in 2st week (0.8 gm). In this treatment average weight gain was (1.05 ± 0.80) gm. In T₃ the highest weight gain was found in 8th week (3gm) and the lowest was recorded in 5th week (1.1 gm). Average weight gain in T₃ was (1.97 ± 1.12) gm (Fig. 8).

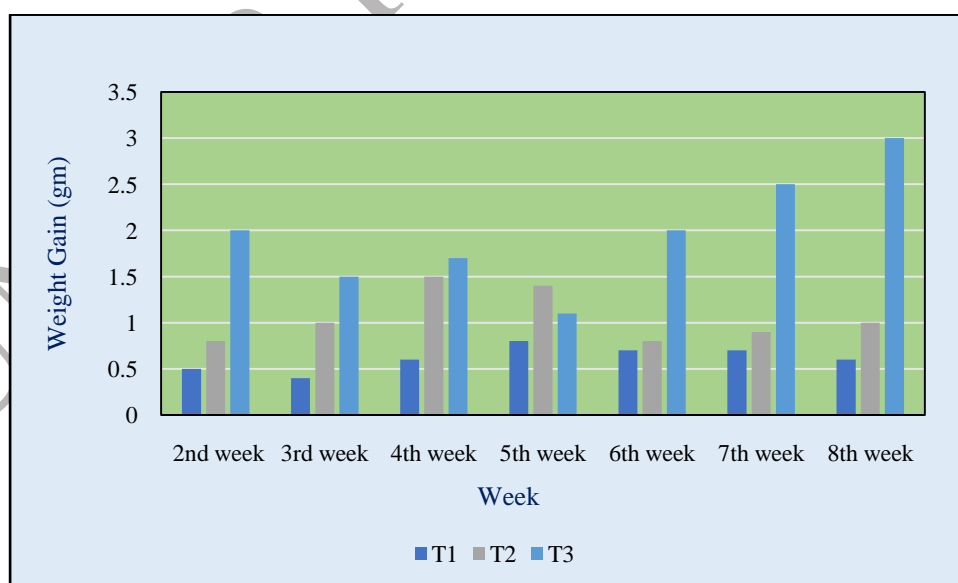


Fig. 8: Variation in weight gain of *Oreochromis niloticus* in different treatment

Length gain of Oreochromis niloticus

Length gain of *Oreochromis niloticus* was observed during the whole study period in different treatments. Final average length gain was 6.55 cm, 8.54 cm and 10.4 cm in T₁, T₂ and T₃ respectively. In T₁ highest length gain was found in 2nd week (0.6 cm) and the lowest was in 8th week and 3rd week (0.4 cm). Average length gain in T₁ was (0.454±0.26) cm. In T₂ highest length gain was found in 8th week (0.9 cm) and lowest was in 3th week (0.5 cm). The average length gain of T₂ was found (0.685±0.69) cm. In T₃ highest growth was found in 8th week (1.5 cm) and lowest was in 5th week (0.7 cm). The average length gain was (0.967±0.62) cm (Fig. 9).

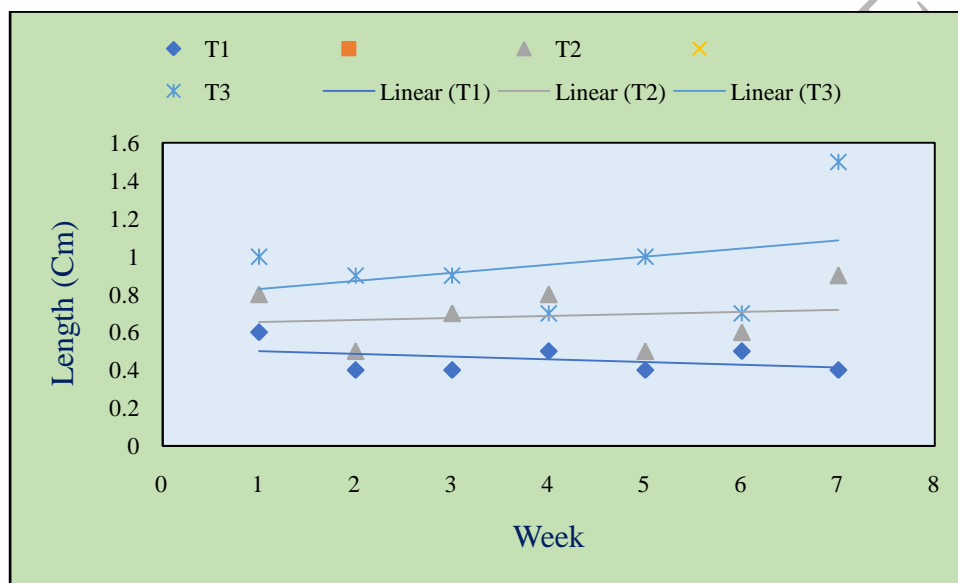


Fig. 9: Variation in length gain in different treatment

Survival rate

The survival rate of fish was calculated and found variable in different treatments. Highest survival rate was found 96% in T₃. In T₁ survival rate was lowest and found 90%. In T₂ survival rate was 93%. The variation in survival rate was due to environmental conditions and different feeding percentages and feed utilization (Fig. 10).

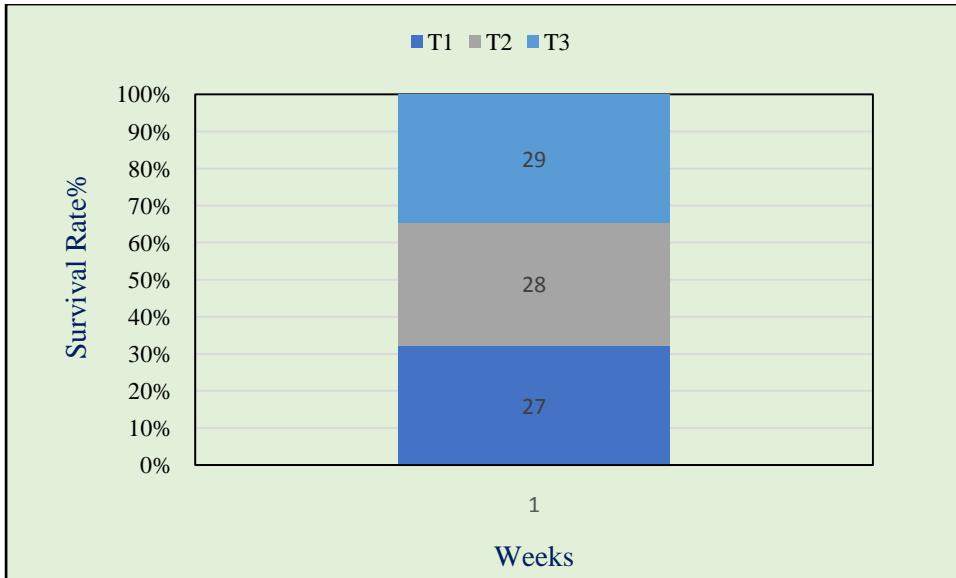


Fig. 10: Survival rate of fry in different treatment

Observation of FCR

FCR of the two experimental treatment (T_2 & T_3) was calculated after the study. In T_2 FCR is found 2.4 and in T_3 FCR was found 3.6. In T_1 no feed were supplied this is why FCR was not applicable for that treatment (Fig. 11).

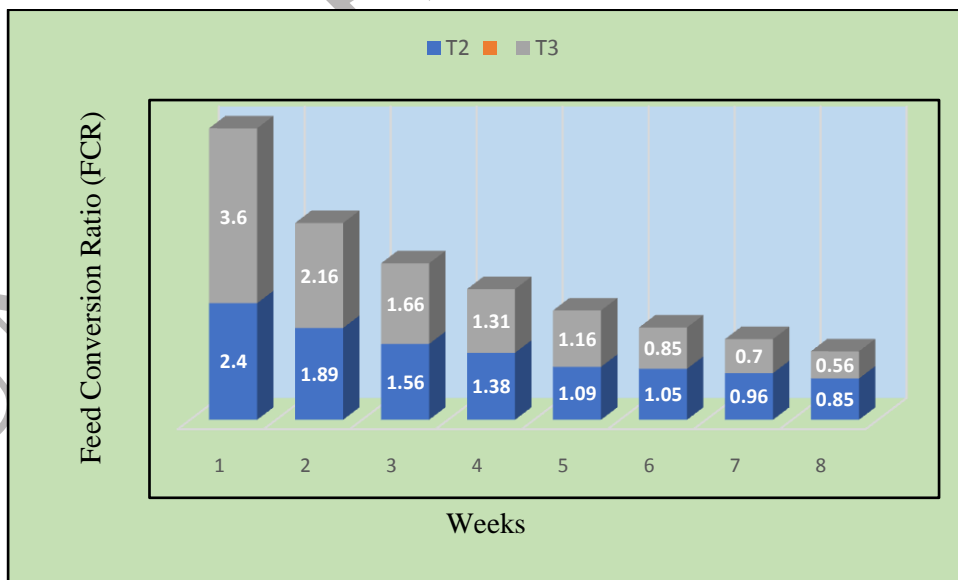


Fig11: Variation of FCR in different treatment

Discussion

Weight performance of Tilapia

The mean initial weight of fish fry in all three treatments were 3 g. At the end of the study, the mean weight of *O. niloticus* were (6.8±4.77) g, (9.35±5.76) g and (19.2±9.9) g in T₁, T₂ and T₃, respectively. The mean weight gains of fry at the end of the experiment were highest in T₃. The mean weight of *Tilapia* fry at harvest was higher in T₃ (19.2±9.9g), followed by T₂ (8.5±5.76 g) and T₁ (6.8±4.77g). The highest weight gain of *O. niloticus* was observed in T₃ in which feed was given according to 12% body weight of the fish. Binh et al. [11] carried out an experiment in metal cage and found similar results in case of *O. niloticus* by feeding formulated diet prepared by locally available material and used feed daily at a rate that decreased with fish growth from 15% to 3% of body weight. Hussain et al. [12] and Hasan et al. [13] reported a weight gain of about 128 g for *Tilapia* in on-farm ponds for a culture period of 6 months fed rice bran at 5-6% of their body weight. Considering the 8 weeks culture period in this study, compared to 6 months period by [12], *Tilapia* in the present study performed better in respect of weight gain.

Length gain

The mean initial length of fish fry in all three treatments were 5 cm. At the end of the study, the mean length of *Tilapia* was (8.2± 6.65) cm, (9.8± 7.36) cm and (12± 8.23) cm in T₁, T₂ and T₃, respectively. The mean length gains of fry at the end of the experiment were highest in T₃. The mean length of *Tilapia* fry at the end of the study was higher in treatment T₃ (12 cm), followed by T₂ (9.8cm) and T₁ (8.2cm). Olurin & Aderibigb [14] collected One hundred juvenile of *O. niloticus* after the end of the experiment and found the length of fish ranged from 5.5 to 11.4 cm. In the present study the highest average length was in T₃ (11.38) which was almost similar to the findings of [14].

Survival rate (%)

The mean survival rates of *O. niloticus* were recorded 93% in all three treatments. During the study period. In the present study, higher survival was achieved as the fish can survive under adverse conditions like low oxygen, high temperature and high pH value. The results of present study were close to the research findings of [15] who observed that the survival rates of koi (*Anabas testudineus*) were varied from 60-80%. The result of this study also agrees with Kohinoor [16] for T₁ and T₃ who reported that the survival rates of *O. niloticus* varied from 79%-92%.

Food Conversion Ratio (FCR)

In the present study, Food Conversion Ratio (FCR) values for Tilapia fry with the commercial feed was 3.60 and 2.40 in T₁ and T₂, respectively. Lower FCR value (2.40) was obtained in T₂ with supplemental feed at the rate of 8% body weight. Ahmed *et al.* (2013) found that Food Conversion Ratio (FCR) was 1.51 and 1.40 respectively in homemade and commercial feed treatments in Tilapia. Hossain *et al.* [17] found FCR value formulated diet was 1.71-1.77 which was little different from the present study. This difference could be due to the fact temperature and geographical location difference as well management. In the present study moisture content was 11% which could also a cause of higher FCR value. Cruz and Laudencia [18] indicated that the fingerlings need 2030% crude protein in ration to give optimum results in ponds. The feed in T₂ and T₃ of the present study also contained crude protein within similar range. So, the change in FCR is not due to protein in feed.

Water quality parameters

The growth, reproduction, survivability and other activities of fish are largely depending on temperature. Clarke [19] reported that metabolic rates of organisms increase with the increase of temperature. Again Clarke [20] showed that perciform fish have not developed a mechanism that allows them to adapt to the cold environment. Therefore, temperature has a remarkable effect on overall production of fish. During the present study, the water temperatures were between 28°C and 32°C. Azaza *et al.* [21] suggested that the growth and feed utilization of *Oreochromis niloticus* juveniles may be higher at 26 and 30 °C. In the present study the temperature rang was higher than Azaza. On the other hand, Ridha [22] reported that the optimum temperature for feeding is between 28.8 and 31.4°C and the fastest growth rate was at 31.4°C, at which the fish averaged an increase of 3.42% of their body weight in 24 h. This temperature range is similar to the present study. Ridha [22] showed that 29.0±1.0°C temperature of water can give a remarkable growth (p<0.5) for *O niloticus*.

Dissolved oxygen of a water body is very important factor for fish culture. During the present study, dissolved oxygen content was between 5.8 to 7.40 mg/l. DoF [23] reported that suitable DO for fish culture is from 5.0 – 8.0 ppm. The DO level of present study is not similar to DoF report. This is due to environmental condition, type of water body and geographic location. Mollah & Haque [24] reported that DO level is 1.19 – 7.74 mg/l on average in two ponds in BAU Campus. The findings of present study are similar to his study.

The range water of pH level in this study was 7.4 to 8.5. According to [23] the optimum level for pH is 6.5 to 8.5. The level of pH in the present study is in optimum level according to [25] also described that pH level from 6.5 to 8.0 is acceptable for culture. The pH level from 5.66-7.66 is suitable for fish culture [24]. In comparison with the study of [24], the pH level in the present study is little high. This is due to several environmental condition, geographical location and other operational factors.

Conclusion

Due to its rapid development and affordable price *O. niloticus* is well-liked and encourages fish producers around the nation 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.

References

1. DoF (Department of Fisheries) (2023). Matsha Pakkah Shankalan. Directorate of Fisheries, Government of People's Republic of Bangladesh, Dhaka, Bangladesh
2. FAO, I. (2022). World Food Programme. The state of food insecurity in the world, 2014. p.12.
3. Tsadik, G. G., & Bart, A. N. (2007). Effects of feeding, stocking density and water-flow rate on fecundity, spawning frequency and egg quality of Nile tilapia, *Pangasius hypophthalmus* (L.). Aquaculture, 272(1), 380-388
4. FAO, I. (2015). WFP (2015). The state of food insecurity in the world 2015. p.17.
5. Budihastuti R. Analysis on the feeding habit of tilapia (*O. niloticus*) cultured in silvo fishery pond in Semarang. J. Ecol. Environ. 2013;4(2):122-131. Available: <http://dx.doi.org/10.5296/jee.v4i2.3950>

6. Garcia JA, Villarroel M. Effect of feed type and feeding frequency on macrophage functions in tilapia (*O. niloticus*). *Fish Shellfish Immunol.* 2009;27(2):325-329
7. Nahar N. Effect of feeding frequency on the growth and production performance of monosex male tilapia (*Oreochromis niloticus* L). MS Thesis, Department of Aquaculture, Faculty of Fisheries, BAU, Mymensingh; 2011.
8. Herawati VE, Hutabarat J, Radjasa OK. Growth and survival rate of tilapia (*Oreochromis niloticus*) larvae fed by daphnia magna cultured with organic fertilizer resulted from probiotic bacteria fermentation. *Hayati J. Biosci.* 2015;22(4): 169-173.
9. Githukia CM, Ogello EO, Kembanya EM, Achieng AO, Obiero KO, Munguti JM. Comparative growth performance of male mono-sex and mixed sex Nile tilapia (*Oreochromis niloticus* L.) reared in earthen ponds. *Crotian. J. Fisheries.* 2015; 73:20-25. DOI: 10.14798/73.1.788
10. Chakraborty SB, Banerjee S. Comparative growth performance of mixed-sex and monosex Nile tilapia at various stocking densities during cage culture. *Recent Research in Science and Technology.* 2012; 4:46-50.
11. Binh, C. T., Lin, C. K., & Demaine, H. (1997). Evaluation of low-cost supplemental diets for culture of *Pangasius hypophthalmus* (L.) in North
12. Hussain, M. G., Kohinoor, A. H. M., Islam, M. S., Mahata, S. C., Ali, M. Z., Tanu, M. B. & Mazid, M. A. (2000). Genetic evaluation of GIFT and existing strains of Nile tilapia, *Pangasius hypophthalmus* L., under on-station and on-farm conditions in Bangladesh. *Asian Fisheries Science*, 13(2), 117-126.
13. Hasan, M.R., Haque, A.K.M., Islam, M.A. and Khan, E.U.M.K. (1992). Studies on the effect of stocking density on the growth of Nile tilapia in floating ponds. *Bangladesh Fisheries*, 2 73-81
14. Olurin, K. B., & Aderibigbe, O. A. (2006). Length-weight relationship and condition factor of pond reared juvenile *Pangasius hypophthalmus*. *World journal of Zoology*, 1(2), 82-85.
15. Felt, R. A., Rajts, F., & Akhteruzzaman, D. (1998). Small Indigenous Fish Species Culture in Bangladesh. Integrated Food Assisted Development Project (IFADEP), Dhaka, Bangladesh.
16. Kohinoor, A.H.M. (2000). Development of culture of technology of three small indigenous fish mola (*Amblypharyngodon mola*), punti (*Puntius sophore*) and chela (*Chela cachius*) with notes on some aspects of their biology. PhD Dissertation, Department of Fisheries Management, BAU, Mymensingh.
17. Hossain, M. A., Roy, R., Rahmatullah, S. M., & Kohinoor, A. H. M. (2004). Effect of stocking density on the growth and survival of (*Pangasius hypophthalmus*) fed on formulated diet. *Journal of Agricultural Rural Development* 2(1), 127-133.

18. Cruz, E. M., & Laudencia, I. L. (1998). Preliminary study on the protein requirement of (*Pangasius hypothalamus*) fingerlings. Fish Res. I. Philippines, 3, 34-38.
19. Clarke, A. (2004). Is there a universal temperature dependence of metabolism? Functional Ecology, 18(2), 252-256.
20. Clarke, A., & Johnston, N. M. (1999). Scaling of metabolic rate with body mass and temperature in teleost fish. Journal of Animal Ecology, 68(5), 893-905.
21. Azaza, M. S., Dhraief, M. N., & Kraiem, M. M. (2008). Effects of water temperature on growth and sex ratio of juvenile Nile tilapia *Pangasius hypothalamus* (L) reared in geothermal waters in southern Tunisia. Journal of thermal Biology, 33(2), 98-105.
22. Ridha, M. T. (2006). Comparative study of growth performance of three strains of Nile tilapia, *Pangasius hypothalamus*, L. at two stocking densities. Aquaculture Research, 37(2), 172-179.
23. DoF (Department of Fisheries) (1996). Matsha Pakkah Shankalan. Directorate of Fisheries, Government of People's Republic of Bangladesh, Dhaka, Bangladesh
24. Boyd, C. E. (1984). Water quality in warm water fishponds. Auburn University, Agricultural Experimental Station, Auburn, Alabama, USA. pp. 359
25. Mollah, M. F. A., & Haque, A. K. M. A. (1978). Studies on monthly variations of plankton in relation to the physico-chemical conditions of water and bottom soil of two ponds. Phytoplankton. Bangladesh J. Fish, 1(1), 29-39.