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 study was designed with three experimental hapas namely T_1, T_2 and T_3 for a period of 8 weeks commencing from 06^{th} October to 06^{th} December, 2017 to assess the effect of feeding ration on the growth and survival rate of *Oreochromis niloticus*. The experiment. The hapas were equal in size (0.0725 decimal) and rectangular in shape. A stocking density of 420 fish/decimal was used for the experiment in all three treatments. The fish were dependent on natural food in T_1, fed at the rate of 8% of their body weight in T_2 and the feeding rate was 12% in T_3. Feeding frequency was two times in a day in T_2 and T_3. The proximate composition of the experimental diet (% dry matter basis) was moisture 11%, protein 30%, fat 6%, ash 10% and fiber 7%. 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 during the experimental period. The mean initial weight of Tilapia fry in three treatments were 3g and the mean final weight of tilapia was (6.8±4.77) g for T_1, (9.88±5.76) g for T_2 and (19.2±9.9) g for T_3, respectively. The mean initial length was 5 cm in three treatment and final length was found (8.2±6.15) cm, (9.86±7.36) cm and (12±8.23) cm in T_1, T_2 and T_3, respectively. The highest weight and length gain was found in T_3 having the feeding rate of 12% of the body weight and lowest was found in T_1 in which no supplementary feed was used.

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 (DoF, 2015), representing a crucial source of micro-nutrients and possessing an extremely strong cultural attachment. The economy of Bangladesh is primarily based on Agriculture and fish (including shrimp and prawn) and fish is the second most valuable agricultural crop, and its production contributes to the livelihoods and employment of millions. Fisheries contribution to agricultural GDP 23.12% and fisheries contribution to national GDP 3.69% (DoF, 2015). The employment of people (full time & part time) approximately 11% of the total population which in number 17.80 million is involved in fisheries (DoF, 2015). Bangladesh earns 630.24 $ million foreign exchanges by exporting fish and fisheries product in 2013-14 (DoF, 2015). In Bangladesh the aquaculture production from inland closed water-bodies is 55.15% of the total production. (FRSS, 2015). Bangladesh ranked 5th as aquaculture producing country in the world (FAO, 2015).

The Nile tilapia, *Oreochromis niloticus* is a widely cultured species because it grows and reproduces in a wide range of environmental conditions and tolerates stress induced by handling (Tsadik and Bart, 2007). It is currently ranked second only to carps in global production. The predominant advantage of monosex culture can be achieved in such aquaculture situations. *Oreochromis niloticus* has been considered as one of the most important species of fish in tropical & sub-tropical aquaculture (FAO, 2014). 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. 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.

However, feeding frequency is generally used to refer how many times the organisms should be fed in a day. It is considered to be one of the important factors that affect fish growth, feed utilization and gross fish yield. The full utilization of space for maximum fish production through intensive culture can improve the profitability of the fish farm. Tilapia has established a secure position in a number of water impoundments of Bangladesh, where one sex displays remarkable growth superiority. 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. Therefore, it is important to standardize the feeding frequency for the target species in aquaculture for desired growth. 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 *Oreochromis niloticus* response best.

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 study area collected from google maps

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 *Oreochromis niloticus* and in T_3 feed was given 12% of the body weight (Table. 01). 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 *Oreochromis 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 (*Oreochromis 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±0.3mm) 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 02: Composition of 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 T_1, no supplementary feed was supplied, T_2 feed were supplied according to 8% of the body weight of the fish and for T_3 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

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

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.

Treatment	Parameter	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th 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

Table 03: water quality parameter

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 T_1 during the study period and it was 8.13 (Fig. 3).

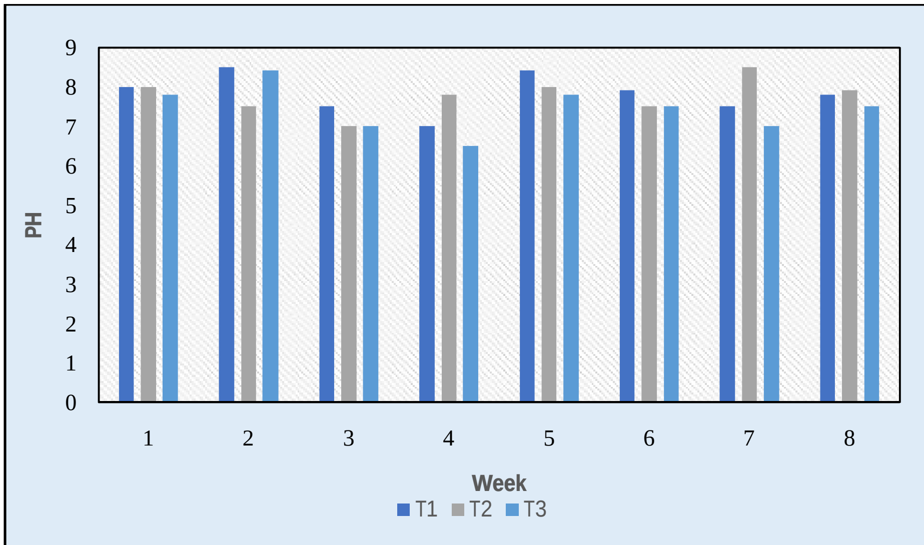

Fig. 3: Variation of water pH during the study period

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).

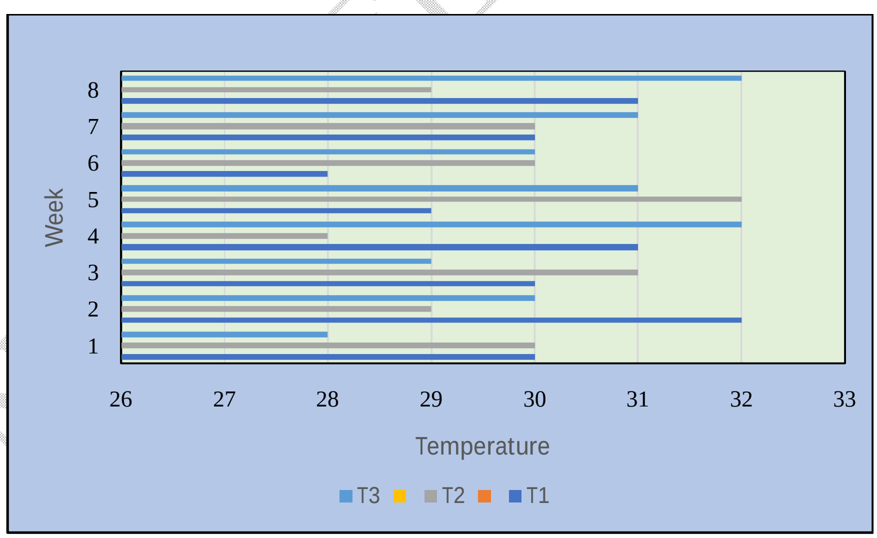

Fig. 4: Variation of water temperature during study period

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).

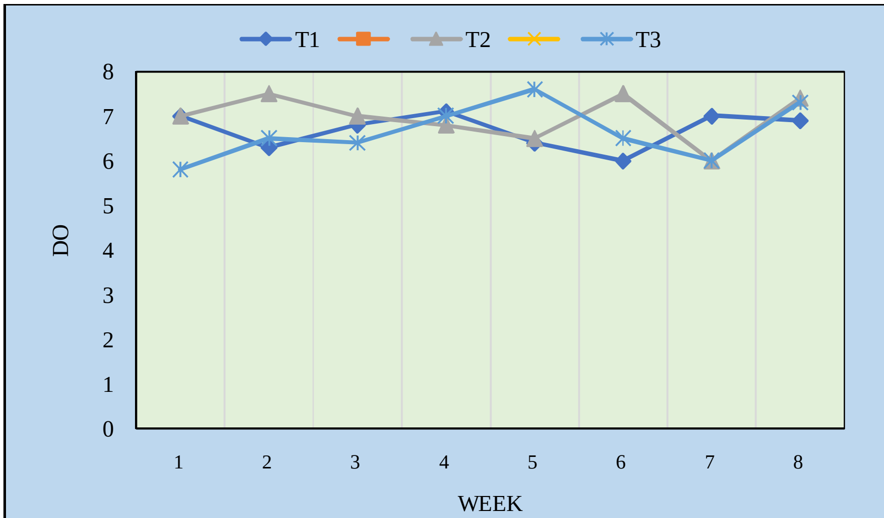

Fig. 5: Variation of water DO during study period

Growth performance of Oreochromis niloticus

Growth performance of Tilapia in different treatment was calculated by weight gain and increase in length. The evaluation of growth performance of *Oreochromis 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 *Oreochromis niloticus* variable in different treatment. Weight of all fish increased with the time interval (from 1^{st} week to 8^{th} week). At the end of the experiment, average weight of *Oreochromis niloticus* in T_3 was found (19.2±9.9) gm, in T_2 weight was found (9.35±5.76) gm, in T_1 average weight was found (6.8±4.77) gm. The average weight gain of T_3 was found higher and lower in T_1 (Fig. 6).

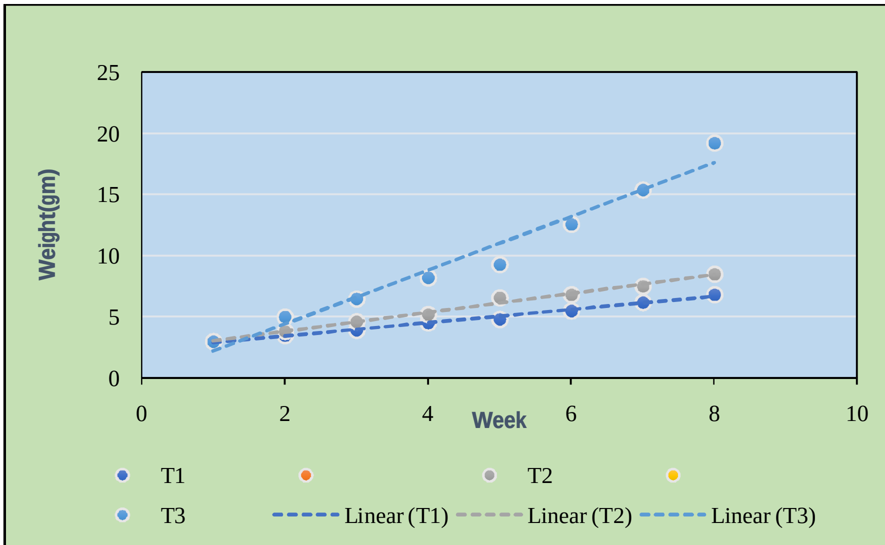

Fig. 6: Weight performance of Tilapia fry in different treatments

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 T_1, T_2 and T_3, respectively. Increase in length was notable in T_3. Average increase in length was highest in T_3 than other three treatment. On the other hand, increase in length was found lowest in T_1 (Fig. 7).

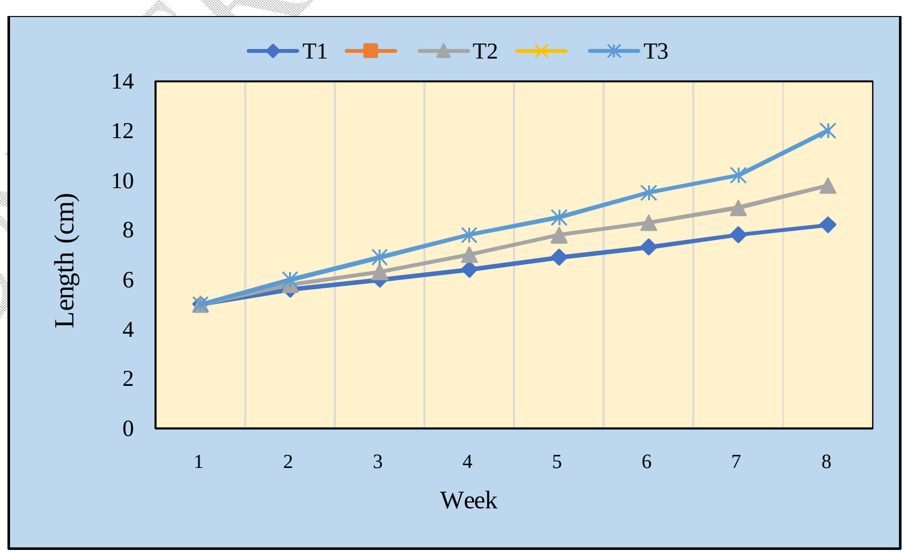

Fig. 7: Length performance of *Oreochromis niloticus* fry in different treatment

Weight gain of Oreochromis niloticus

Weight gain of *Oreochromis niloticus* fish fry was observer 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 T_1, T_2 and T_3, respectively. In T_1 weight gain was almost similar in every week. The average weight gain in T_1 was (0.677±0.40) gm. In T_2 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 T_3 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 T_3 was (1.97±1.12) gm (Fig. 8).

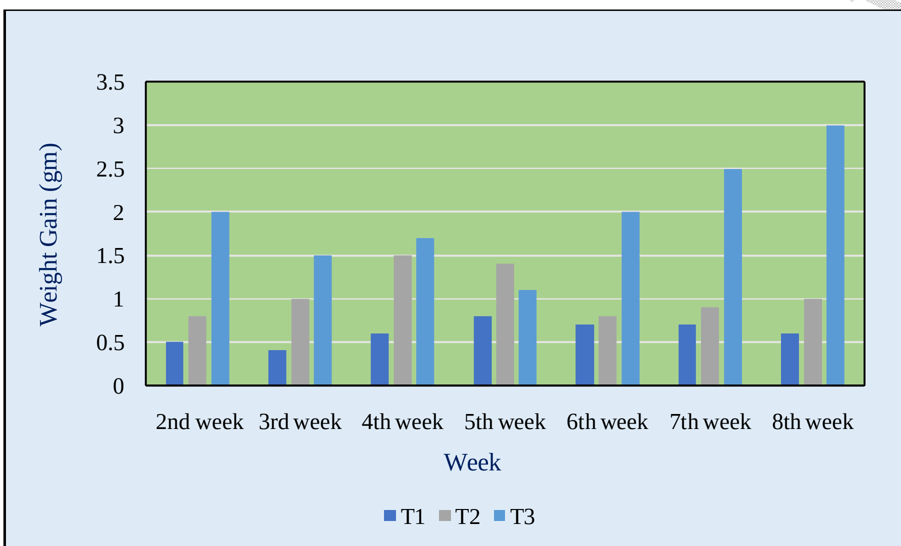

Fig. 8: Variation in weight gain of *Oreochromis niloticus* in different treatment

Length gain of Oreochromis niloticus

Length gain of *Oreochromis niloticus* was observe during the whole study period in different treatment. Final average length gain was 6.55 cm, 8.54 cm and 10.4cm in T_1, T_2 and T_3 respectively. In T_1 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 T_1 was (0.454±0.26) cm. In T_2 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 T_2 was found (0.685±0.69) cm. In T_3 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).

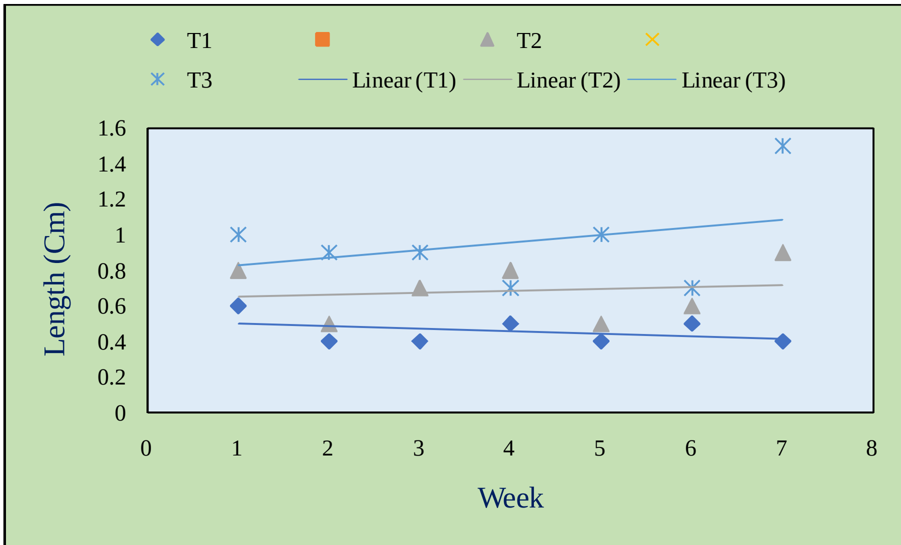

Fig. 9: Variation in length gain in different treatment

Survival rate

The survival rate of fish was calculated and found variable in different treatment. Highest survival rate was found 96% in T_3. In T_1 survival rate was lowest and found 90%. In T_2 survival rate was 93%. The variation in survival rate was due to environmental condition and different feeding percentage and feed utilization (Fig. 10).

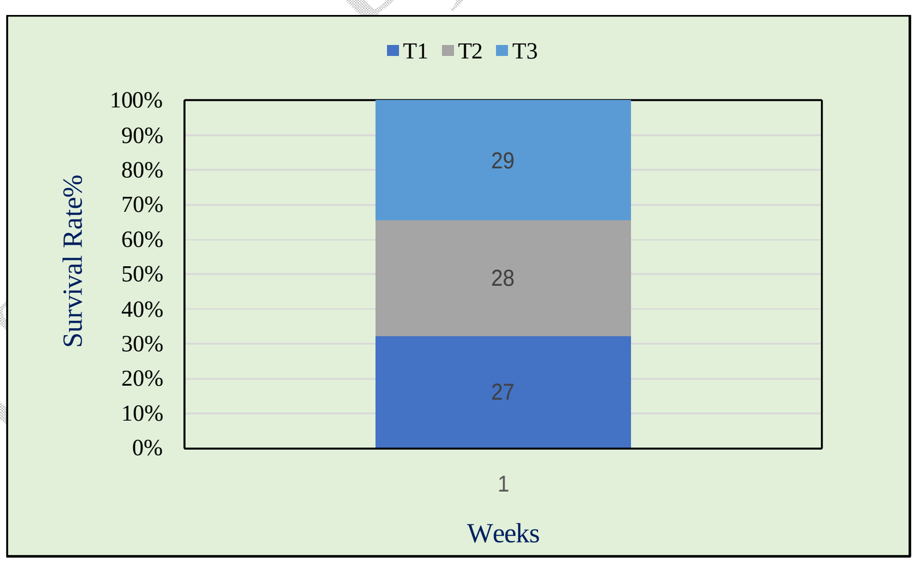

Fig. 10: Survival rate of fry in different treatment

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).

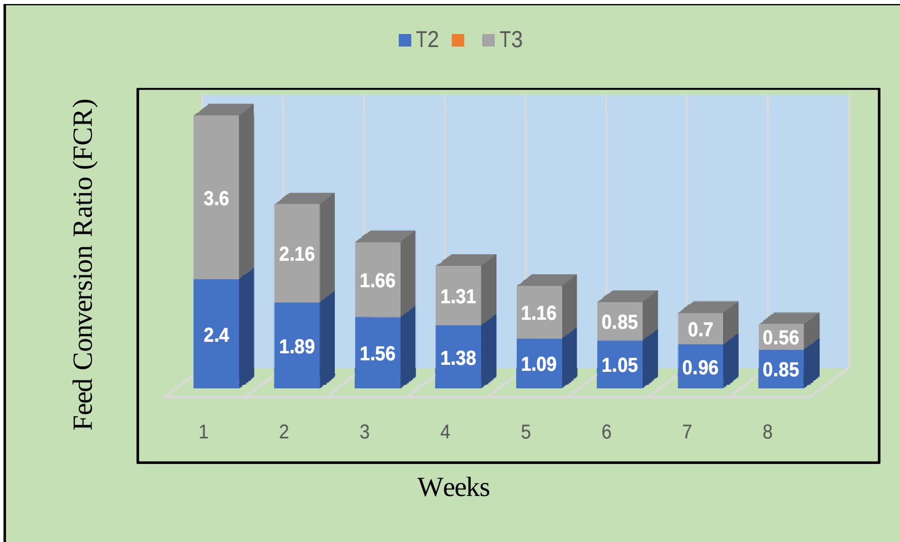

Fig11: Variation of FCR in different treatment

Discussion

Growth parameters

Weight performance

The mean initial weight of fish fry in all three treatments were 3 g. At the end of the study, the mean weight of *Oreochromis niloticus* were (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. 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 T_3 (19.2±9.9g), followed by T_2 (8.5±5.76 g) and T_1 (6.8±4.77g). The highest weight gain of *Oreochromis niloticus* was observed in T_3 in which feed was given according to 12% body weight of the fish. Binh *et al*. (1997) carried out an experiment in metal cage and found similar results in case of *Oreochromis 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*. (2000) and Hasan *et* *al*. (1992) 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 Hussain *et al*. (2000), Tilapia in the present study performed better in respect of weight gain.

Length performance

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 T_1, T_2 and T_3, 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 T_3 (12 cm), followed by T_2 (9.8cm) and T_1 (8.2cm). Olurin & Aderibigb (2006) collected One hundred juvenile of *Oreochromis 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 T_3 (11.38) which was almost similar to the findings of Olurin & Aderibigh (2006).

Survival rate (%)

The mean survival rates of *Oreochromis 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 Felt *et. al*. (1998) who observed that the survival rates of koi (*Anabas testudineus*) were varied from 60-80%. The result of this study also agrees with Kohinoor (2000) for T_1 and T_3 who reported that the survival rates of *Oreochromis 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 T_1 and T_2, respectively. Lower FCR value (2.40) was obtained in T_2 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 a1*. (2004) 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 (1998) indicated that the fingerlings need 2030% crude protein in ration to give optimum results in ponds. The feed in T_2 and T_3 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

Reproduction, growth, survivability and other activities of fish are largely depending on temperature. Clarke (2004) reported that metabolic rates of organisms increase with the increase of temperature. Again Clarke (1999) 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.* (2008) 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, Platt & Hauser (2011) 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 (2006) showed that (29.0±1.0) °C temperature of water can give a remarkable growth ($p<0.5$) for (*Oreochromis 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 (1996) 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 (1978) 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 DoF (1996) 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 Boyd (1984) also described that pH level from 6.5 to 8.0 is acceptable for culture. But Mollah & Haque (1978) said that pH level from 5.66-7.66 is suitable for fish culture. Compared to Mollah & Haque (1978) pH level in the present study is little high. This is due to several environmental condition, geographical location and other operational factors.

Conclusion

Oreochromis niloticus has a high acceptance among the people of Bangladesh for its fastest growth, low price and good test. This influences fish farmers to culture this species throughout the country. In order to have a good profit farmers need to apply additional food as natural food is not always enough for the higher growth in a limited time. In the view of economic aspect, using commercial or supplemental feed in aquaculture should ensure minimum wastage of feed because feed constitute the major part of the total budget and low feeding rate can reduce the target growth. For that reason, fish farmer should have proper knowledge about the exact feed requirement of the fish. Under the experimental condition, different treatments showed different growth rates. In the present study, the mean final weight was higher in T_3. Although the individual weight gain in T_3 was highest which might be due to difference in feeding rate. Based on the present experimental condition, it can be recommended that the optimum feeding rate for Tilapia in hapa condition is 12% of their body weight compared to 8% and only natural food is not sufficient for the profitable growth.

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