Effects of Different Feeding Frequencies on Growth Performance and Feed Conversion Ratio (FCR) of Tilapia, *Oreochromis niloticus*

Abstract

The study was conducted to assess the growth performance and feed conversion ratio (FCR) of *Oreochromis niloticus* fry reared in experimental ponds. A stocking density of 360 fish/decimal with three feeding frequency T_1 (five times/day), T_2 (four times/day) and T_3 (three times/day) was maintained each with three replications. The fry was initially fed at 30% of their body weight and the rate was reduced up to 5% gradually at the final stage. The highest weight gain, percent weight gain and SGR were showed in T_1 and lowest was found in T_3. The survival rate was 95.65, 92.45 and 90.34% in T_1, T_2 and T_3, respectively. The best FCR value was obtained in T_1 (0.983) and the significantly ($P<0.05$) highest fish production was also observed in T_1 (66.76 kg/dec/120 days). At the end of the experiment, the mean weight gain was recorded as 327.49, 298.65 and 253.72 g, respectively. The highest percent weight gain (%) was observed in T_1 (5468.78) followed by T_2 (5178.84) and T_3 (4297.89). The specific growth rate (SGR) was also highest in T_1 (3.48) while the lowest SGR was found in T_3 (3.21%). The result revealed that feeding frequency effect positively on the growth performance of Tilapia.

Keywords: Feeding Frequency, Growth performance, Survival rate, Tilapia.

Introduction

Oreochromis niloticus, the Nile tilapia, is an extensively cultivated species because it can grow and reproduce in a variety of environmental circumstances and can withstand handling-induced stress (Tsadik and Bart, 2007). In terms of global output, it is currently only surpassed by carps. In such aquaculture circumstances, it is possible to accomplish the primary benefit of monosex culture. According to the FAO (2014), one of the most significant fish species for tropical and subtropical aquaculture is *Oreochromis niloticus*.

The Nile tilapia, *Oreochromis niloticus,* is probably the most significant food fish and the species that is most frequently cultivated in the twenty-first century worldwide (Ridha, 2006). The use of the male monosex population is necessary for commercial tilapia production because males grow by about 30% more than females. All male tilapia populations can be obtained affordably and effectively by administering androgen hormone (17-methyl testosterone) (Guerrero et al., 1988). Thus, it's crucial to consider the variables that affect its production, such as the type of feed, ration size, different feeding frequencies, and their potential effects on growth and feed utilization. According to De Silva and Anderson (1995), feeding frequently is essential to achieving the highest possible food conversion ratio and weight of cultured organisms. Faster growth and size homogeneity may result from higher feeding frequencies that reduce combative behavior. Additionally, feeding frequency can impact water quality, survival, body composition, and growth performance (Zhou et al., 2003; Zakes et al., 2006).

The term "feeding frequency" typically refers to how frequently an organism should be fed during the day. It is regarded as one of the crucial elements that impacts fish productivity, feed consumption, and growth. The goal of the current study is to assess the growth performance of a tilapia culture under various feeding percentages by measuring the feeding rate and frequency of an all-male monosex tilapia population. The effective management of feed, husbandry tactics (Lovell, 1998; Olurin, & Aderibigbe, 2006), and broadcasting of the specified ration to the culture system are essential methods for cutting feed costs in commercial aquaculture. Thus, one of the most important aspects of culture practice may be pointed to as the act of feeding.

In order to achieve the intended growth, it is crucial to standardize the feeding frequency for the target species in aquaculture. The main goal of the study was to determine the appropriate feeding rate and frequency for *Oreochromis niloticus*, a significant fish species used in aquaculture in Bangladesh. The impact of feeding frequency on development outcomes for different species had already been explored by a number of authors (Kasiri et al., 2011; Pouomogne and Ombredane, 2001). The impact of feeding frequency on the growth performance of tilapia raised in ponds, however, is still quite minimal. In order to ensure that *O. niloticus* fingerlings grow and survive in the best possible conditions, the current research was conducted with the goal of determining an appropriate feeding frequency.

Methods & Materials

Study Area and Experimental design

Three experimental ponds with three replications each were used to conduct the experiment during a 120-day period (Table 1). A fish farm in Tarakanda upazila, which is part of the Mymensingh district, served as the site of the experiment, which ran from September 20 to December 20, 2019. Nine ponds were utilized for the experiment. a stocking density of 360 fish per decimal with three feeding frequencies: T_1 (five times/day), T_2 (four times/day), and T_3 (three times/day). A commercial kit box was used to measure water quality parameters like temperature, dissolved oxygen, and pH after the pelleted feed (Quality Feed) had been applied to the experimental ponds.

Table 1: Experimental layout of *Oreochromis niloticus*

Treatment	Replications	Size of the Ponds (Dec)	Stocking density/Dec	Feeding Frequency (times/day)
T_1	R1 R2 R3	32	360	5
T_2	R1 R2 R3	32	360	4
T_3	R1 R2 R3	32	360	3

Study of growth parameters of fish

To monitor the growth and health of the fry, periodic sampling was carried out every seven days. Fry were carefully scooped up with a scoop net and placed in a water-filled dish. An electric digital balance was used to measure weight. At the time of the last harvest, the mean weight increase (g), specific growth rate (SGR), feed conversion ratio (FCR), and fry survival were noted. Growth parameters were calculated using the following formula:

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

Specific growth rate (SGR, %) = 100 × [(ln BW final (g) -ln BW initial (g)) / days of culture]

Production = No. of fishes harvested × average final weight increases 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)

Sampling and water quality parameters

During the study period, fish were captured with a scoop net, and the weight of each species was then determined using a balance machine. Every seven days, weight data were collected. Fish sampling included keeping an eye on the experimental species' physical health.

Once a week, the following measurements were made: water temperature, oxygen dissolution, pH, and amount of natural food (plankton). During the study period, the experimental water body's water temperature was measured using a mercury Celsius thermometer once every week. The experimental water body's temperature was recorded at the same time every weekday during the study period. During the study period, the pH of the water body was tested once each week. A digital portable pH meter (Model: HANNA- HI 96107) was employed for this operation. A portable DO meter (Model: Lutron-DO-5509) was utilized to quantify the dissolve oxygen of the test water body on-site without taking any water samples for analysis.

Statistical analysis

Before performing the univariate analysis of variance (ANOVA), it was first confirmed that the variance of the data met the requirements. When the value was greater than 5% (P>0.05), the Shapiro-Wilk test and the Levene test were used to confirm the normality and homogeneity assumptions, respectively. When the assumptions were met, the data were presented to an ANOVA, considering that there was a difference when the value was below 5% (P<0.05), and in this instance, they were submitted to the Tukey test for the comparison of means; this was also done using the 5% threshold. Utilizing the statistical program SPSS, every statistical analysis was carried out.

Results

Growth performance of fish

The mean weight gain, percent weight gain, specific growth rate (SGR%) per day, survival (%), food conversion ratio (FCR), and production (Kg/dec/120 days) were calculated for the evaluation of the proper growth performance of Tilapia fry in various treatments during the experimental period. The results are shown in Table 2.

Table 2: Growth performance of Tilapia

Growth parameters	Treatment		
	T_1	T_2	T_3
Initial weight (g)	5.0±0.00^{a}	5.0±0.00^{a}	5.0±0.00^{a}
Final weight (g)	327.49±2.32^{a}	300.25±0.87^{b}	250.42±2.33^{c}
Weight gain (g)	327.49±2.32^{a}	294.55±0.87^{b}	244.72±2.33^{c}
SGR (%/day)	3.48±0.01^{a}	3.30±0.001b	3.15±0.01^{c}
Survival (%)	95.65±0.367^{a}	93±0.707^{a}	90.5±0.707b
% Weight gain	5468.78±38.87^{a}	5167.54±27.13^{b}	4293.27±17.36^{c}
FCR	0.983±0.0057^{a}	1.07±0.0035^{b}	1.16±0.0113^{c}

Values in the same row having different subscript letters are significantly different ($p < 0.05$)

The mean final weight gain of the fry was 327.49±2.32 g, 294.55±0.87 g, and 244.72±2.33 g for T_1, T_2, and T_3, respectively, at the end of the feeding trial (Fig. 1).

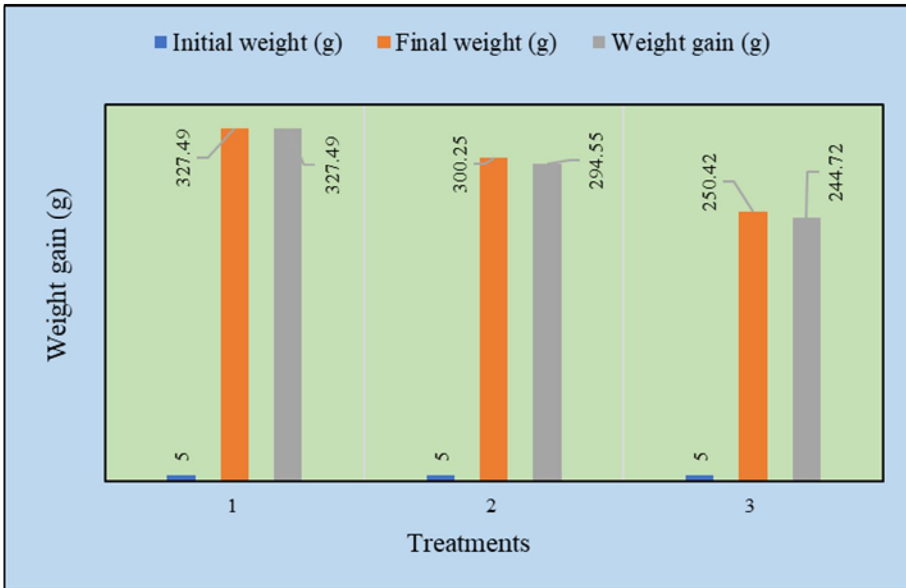

Fig.1: The weight gain of *Oreochromis niloticus* under different treatments

The growth indices varied significantly ($P<0.05$) between the several treated groups. The best (lowest) FCR was obtained in T_1 (0.983±0.0057) in the current investigation, where we discovered that the values of FCR were declining in accordance with the rising feeding frequency.

Weight gain and feed conversion ratio (FCR)

The initial weight of fish in the various treatments did not differ significantly ($p<0.05$). For T_1, T_2, and T_3, the fish gained 327.49, 298.65, and 253.72 g, respectively (Fig. 2). Fish with a feeding frequency of five were found to have the highest weight gain (327.49 g), whereas fish with a feeding frequency of three were found to have the lowest weight gain (253.72 g).

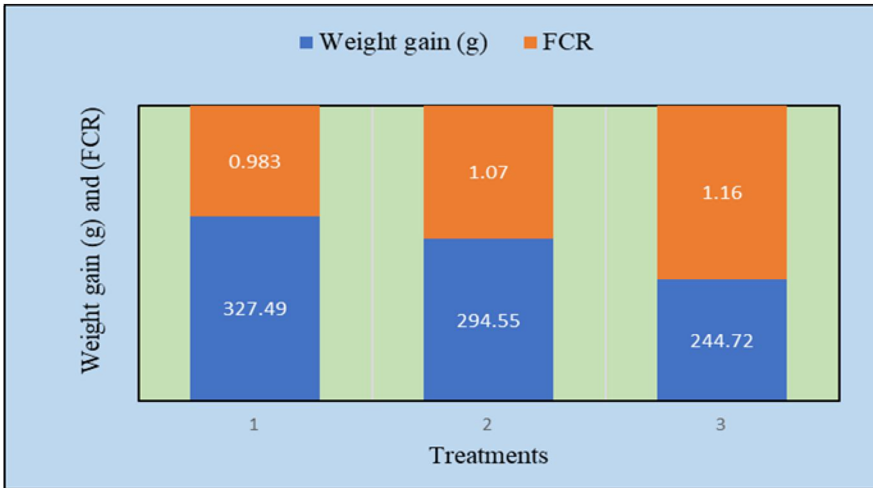

Fig. 2: Weight gain and feed conversion ratio (FCR) at different feeding frequencies

The food conversion ratio (FCR) was found to be 00.983±0.0057, 1.07±0.0035 and 1.16±0.0113, correspondingly, at varied frequencies. T_1 had the mean least FCR value (0.983±0.0057), while T_3 had the greatest mean FCR value (1.16±0.0113). In compared to T_2 and T_3, T_1 had the highest FCR value (0.983) (Fig. 2).

Analysis of diet composition

A proximate composition study of the test diet was performed to confirm the formulation's correctness. Table 3 displays the total findings and the protein content of the fried diet, which was 27.92%.

Table 3: Proximate composition of feed used in experiment.

Name of the major composition	**Amount of composition (%)**
Moisture	12.16
Protein	27.92
Crude fiber	5.25
Lipid	7.93
Ash	15.36
*NFE (Nitrogen free extract)	31.38

Percent weight gain and specific growth rate (SGR%/day)

The percent weight gain of fish was 5468.78±38.87%, 5167.54±27.13%, and 4293.27±17.36%in T_1, T_2, and T_3, respectively. In T_1, which had the highest feeding frequency (five times/day), the percent weight growth was considerably ($P<0.05$) highest (5468.78±38.87%), while in T_3, the least percent weight gain was observed during the study (4293.27±17.36%) (Fig. 3).

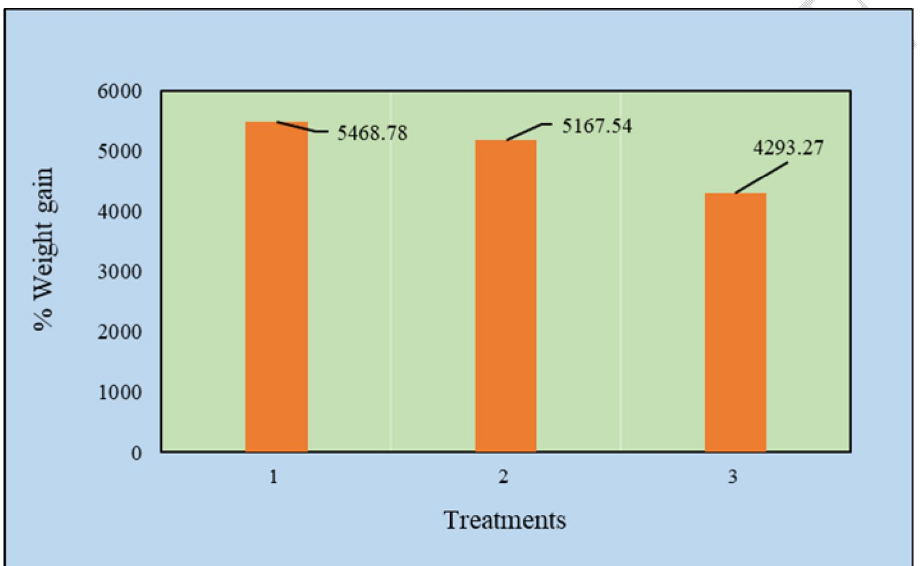

Fig. 3: The percent weight gain (g) in three treatments

The specific growth rates (SGR) of tilapia in treatments T_1, T_2, and T_3 were found to be 3.48±0.01, 3.30±0.001 and 3.15±0.01, respectively. There were variations between the various treatments that were significant ($P<0.05$). SGR gradually rose as feeding frequency increased. The lowest specific growth rate (3.15±0.01) and the considerably greatest specific growth rate (3.48±0.01) were found in T_1 and T_3, respectively (Fig. 4).

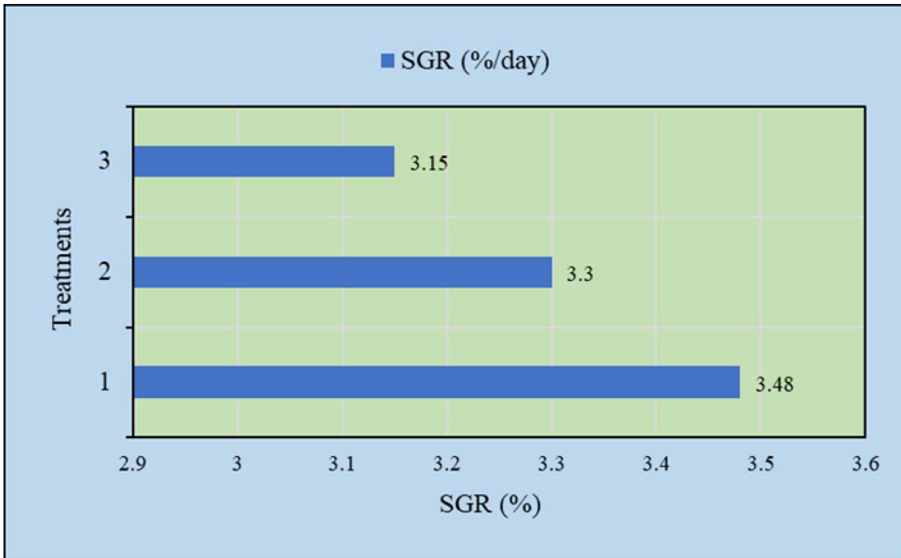

Fig. 4: Specific growth rate (SGR%/day) of Tilapia under different treatments

Water quality parameters (Temperature, pH, DO)

The average water temperature for treatments T_1, T_2, and T_3 was 29.36±1.24, 29.31±1.22 and 29.25±1.19°C, respectively. The average dissolved oxygen level of the water in treatments T_1, T2, and T_3 was 55.12±0.51, 5.14±0.59 and 5.24±0.39mg/l respectively (Table 4).

Table 4: Water quality parameters

Treatments	**Parameters**		
	Temperature (°C)	**Dissolved oxygen (mg/l)**	**pH**
T_1	29.36±1.24	5.12±0.51	7.28±0.34
T_2	29.31±1.22	5.14±0.59	7.76±0.31
T_3	29.25±1.19	5.24±0.39	7.61±0.19

The mean pH values of the water in tests T1, T2, and T3 were, respectively, 7.28±0.34, 7.76±0.31 and 7.61±0.19. Under various treatments during the study period, there were no significant differences in water temperature, DO, or pH values (Table 2).

Survival rate and production (kg/dec/120 days)

The calculation of the fish survival rate revealed that it varied depending on the treatment. The highest survival rate was 95.65±0.367% in T_1, while the lowest survival rate was 90.5±0.707 in T_3. Different feeding percentages and feed consumption, as well as environmental factors, contributed to the difference in the survival rate. According to observations, the production was 65.67±0.52, 56.45±0.32, and 43.73±0.78 kg/dec/120 days in T_1, T_2, and T_3, respectively ((Fig. 5).

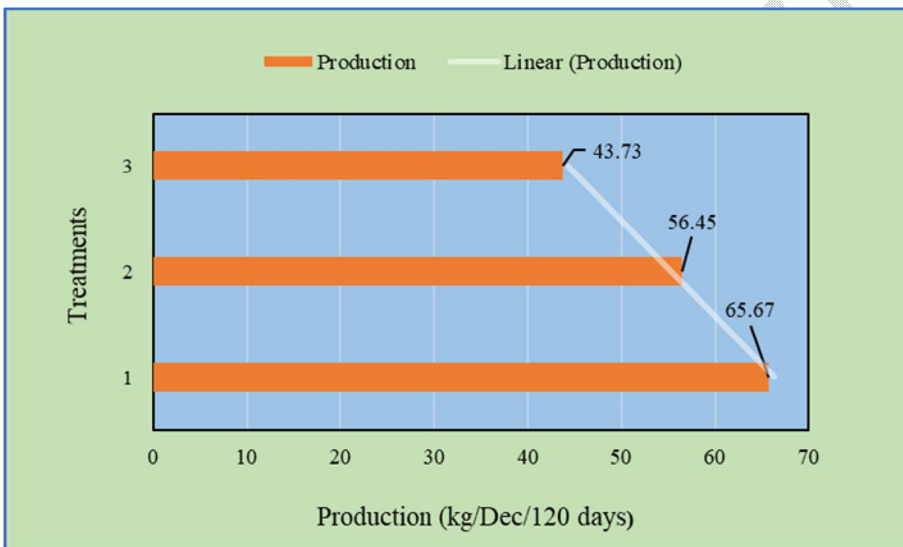

Fig. 5: Production performance at different feeding frequency (T_1, T_2 and T_3)

The significantly ($P<0.05$) highest fish production was determined to be 65.670.52 kg/dec/120 days in T_1 under five times feeding frequencies, and production was shown to considerably decrease with the decrease in feeding frequencies. T_3 had the lowest fish production (43.73±0.78 kg/dec/120 days).

Discussion

Weight performance

In all three treatments, the initial weight of the fish fry was 5.0 g on average. *Oreochromis niloticus* had mean weights of (327.49±2.32) g, (294.55±0.87) g, and (244.72±2.33) g in T_1, T_2, and T_3, respectively. At the end of the experiment, T_1 had experienced the highest mean weight growth. T_1 had the highest mean weight of tilapia fry at harvest (327.49±2.32 g), followed by T_2 (294.55±0.87 g), and T_3 (244.72±2.33 g). In T_1, when meal was provided five times/day, the *Oreochromis niloticus* gained the most weight.

By feeding *Oreochromis niloticus* a prepared diet made from locally accessible ingredients and utilized feed daily at a rate that dropped with fish growth from 15% to 3% of body weight, Binh et al. (1997) conducted an experiment and found comparable results. Tilapia in on-farm ponds for a culture period of 6 months were fed rice bran at 5-6% of their body weight, according to Hussain et al. (2000) and Hasan et al. (1992), who reported a weight rise of about 284.55±0.86 g. Tilapia in the present study fared better in terms of weight gain when comparing the 120-day culture period to the 6month period used by Hussain et al. (2000).

Survival rate (%)

The survivability of tilapia was observed as 95.65±0.367, 93±0.707 and 90.5±0.707 % in T_1, T_2 and T_3, respectively. The highest survivability was recorded in treatment T_1 and the lowest survivability was in T_3. The little variation of survivability was occurred due to environmental condition and feeding frequency. In T_1 feeding frequency was five times in a day so the feed utilization rate was high and the survivability was also high. A more or less similar survival rate was observed by Rahman (2020) who recorded survival rate ranged from 94 to 95%.

Food Conversion Ratio (FCR)

In the current study, the Food Conversion Ratio (FCR) values for Tilapia fry fed commercial feed were 0.983±0.0057, 1.07±0.0035, and 1.16±0.0113, respectively, for T_1, T_2, and T_3. The FCR was lower in T_1 (0.983±0.0057). Food Conversion Ratio (FCR) was determined to be 1.31 and 1.40 in Tilapia treatments fed commercial and homemade feed, respectively, by Ahmed et al. (2013) and Rahman (2000). Hossain et al. (2004) found that the FCR value of formulated diet was 1.51-1.62, which was only marginally different from the current study. The frequency of feeding may have caused this discrepancy.

Water quality parameters

The temperature has a significant impact on fish development, survival, and other functions. According to Clarke (2004), organisms' metabolic rates rise as temperature rises. Once more, Clarke (1999) demonstrated that perciform fish do not possess an adaptation to the cold environment. As a result, temperature significantly affects fish productivity as a whole.

For fish culture, dissolved oxygen in a body of water is a crucial component. The dissolved oxygen concentration in the study ranged from 5.12 to 5.24 mg/l. According to DoF (1996), a range of 5.0 to 8.0 ppm of DO is appropriate for fish production. According to Mollah and Haque (1978), the average DO level ranges from 1.19 to 7.74 mg/l. The findings of present study are similar to his study.

The pH range of the water used in this experiment was (7.28-7.76), which is within the acceptable range. pH should be between 6.5 and 8.5, claims DoF (1996). According to Boyd (1984), the pH level in the current study is optimal. Boyd also said that a pH range between 6.5 and 8.0 is suitable for cultivation. However, according to Mollah & Haque (1978), fish culture is best suited to pH levels between 5.66 and 7.66. The pH level in the current investigation is a little higher than that of Mollah and Haque (1978). This is brought on by various environmental conditions, geographic location, and other operational considerations.

The water's temperature during the current study ranged from 29.25°C to 29.36°C. Azaza et al. (2008) hypothesized that juvenile *Oreochromis niloticus* would grow and use feed more effectively at 26 and 30°C. The temperature range in the current investigation was comparable to Azaza's findings. Contrarily, Cruz & Laudencia (1998) found that the fish averaged an increase of 3.42% of their body weight in 24 hours at 31.4°C, the temperature at which they grew at the highest rate. The ideal feeding temperature was found to be between 28.8 and 31.4°C. The current study's temperature range is similar to this one. According to Ridha (2006), *Oreochromis niloticus* can grow very well ($p<0.05$) at a water temperature of (29.01.0) °C.

Conclusion

In this experiment, the average final weight of the tilapia was 327.49±2.32 g for T_1, 300.25±0.87 g for T_2, and 250.42±2.33 g for T_3. The average weight gain for T_1, T_2, and T_3 was 327.49±2.32 g, 294.55±0.87 g, and 244.72±2.33 g, respectively. The average weight gain was 5468.78±38.87, 5167.54±27.13 and 4293.27±17.36%; the average SGR for T_1, T_2 and T_3 was 3.48±0.01, 3.30±0.001 and 3.15±0.01%, respectively. The fact that T_1 had the highest weight increase, percent weight gain, and SGR could be attributed to the effect of having five feeding frequencies per day, which show efficient feed use. The T_3 group, which only ate three times each day, had the lowest feeding frequencies. The survival rates in T_1, T_2, and T_3 were 95.65±0.367, 93±0.707, and 90.50±0.707%, respectively. For T_1, T_2, and T_3, the FCR values were 0.983±0.0057, 1.07±0.0035, and 1.16±0.0113, respectively. The T_1 experiment, in which fry were fed five times as frequently, produced the best FCR value. The fish production in T_1 was 65.67±0.52 kg/dec/120 days, which was substantially (P<0.05) higher than any other time period. The *Oreochromis niloticus* produced well in terms of growth and output, it can be inferred that feeding frequency was a significant factor.

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