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Research Article

An Experiment on Growth Performance, Specific Growth Rate (SGR) and Feed Conversion Ratio (FCR) of Rohu (*Labeo rohita*) and Tilapia (*Oreochromis niloticus*) in Tank Based Intensive Aquaculture System

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Abstract

The growth and survival are considered as the crucial factors that should be taken into consideration in any aquaculture system. The experiment was aimed to evaluate the growth performance and subsequent survival rate of the rohu (*Labeo rohita*) and tilapia (*Oreochromis niloticus*). It is important to evaluate the growth responses in relation to Feed Conversion Ratio (FCR) and assessment of the total production of the culture unit. As per the recommended stocking density of 320 fishes/decimal in intensive aquaculture system 8 fry per tank was released to assess the growth performance, survival and production of both rohu (T₁) and tilapia (T₂). During experimental period, there were three replications for each treatment and feed was supplied at the rate of 12%, 8%, and 4% of the body weight of rohu and 20%, 15%, and 10% of the body weight of tilapia in 1st, 2nd and 3rd month for T₁ and T₂, respectively. The initial weight of individual tilapia was 7.52±1.81 gm and 14.75±0.19 gm for T₁ and T₂, respectively. The mean final weight was 44.01±4.03 g for T₁ and 139.94±1.29 for T₂. The weight gains of fish were 36.49±4.09 gm and 125.19±1.29 gm for T₁ and T₂, respectively. The mean percent weight gain of tilapia was higher in T₂ (1715.05±0.00) than T₁ (485.23±0.00). The Specific Growth Rates (SGR) of T₁ and T₂ were found 4.98±2.28 and 6.26 ±3.83, respectively. There was significant difference (p>0.05) in term of SGR between the treatments. Feed Conversion Ratio (FCR) in T₁ and T₂ were 2.86±0.14 and 2.23±0.18, respectively. Higher total production was obtained in T₂ (1119.52 gm) than T₁ (278.19 gm) with 100% survival in both the treatments. The water quality parameters for both of the species were within the suitable range. This study reveals a promising arena for fish culture in tank-based intensive aquaculture system as an efficient way of overcoming the scarcity of water and land. This culture system may be an excellent way of producing fish in a small parcel of land with securing the propitious production and expected outcomes within a limited period of time.

Introduction

Aquaculture is the fastest growing animal-based food producing sector particularly in developing countries like Bangladesh and its production contributes to the livelihoods, employment and also meet the demand in terms of protein supply, food security and income generation of the increasing number of people throughout the world [1]. The contribution of fisheries sector in 2019–20 was 3.50% to the total GDP of the country and approximately 25.72% to agricultural GDP

[2]. Now-a-days, fish production shifting to aquaculture as inland fisheries production has escalated over the years, but the productivity per hectare water area is not yet attained at its optimum [2]. Aquaculture is a great revolution in fisheries sectors which has introduced many effective technologies to rear fish and other aquatic animals and has contribution to escalate the total fish production worldwide. Among various segments of the fisheries sub-sector, the inland aquaculture has generally experienced the fastest growth, with the establishment of latest technologies, species, and

intensification and improvement of farming, particularly in pond and tank-based aquaculture, entirely over the country. Aquaculture now provides around half the fish for direct human consumption in Bangladesh and is set to grow further.

The competition between aquaculture and other agricultural sectors is increasing in the context of land and water use. To fulfill the animal protein demand for growing population in Bangladesh intensive fish culture system may be alternative to enhance fish production since fish contributes about 60% of animal protein to our daily food [2]. Therefore, intensive aquaculture is growing to ameliorate the national fish production in the context of population growth and declining land resource to replenish the existing gap. In Bangladesh, conventional semi-intensive aquaculture system is generally followed in case of fish culture besides extensive system. However, with the increasing population land area is declining in Bangladesh. Moreover, fish productions per unit area much higher in intensive aquaculture system compared to semi-intensive and extensive system. Aquaculture ponds are often integrated into conservation and management systems and tank culture are often an efficient way of overcoming the matter of water shortages.

To assess the amount of feed required in percentage increase in size and weight at a particular growth stage in relation to time (SGR) is very important. In this experiment, the stocking density was adjusted to intensive (320 fish/decimal) system achieve the expected result more accurately. The initial and final weight over time but the intermediate data remain unaccustomed calculate growth performance. Therefore, the result is not accurate enough to understand the growth of fish in the intermediary stages of a production cycle [3]. The present study has taken rohu and tilapia as an experimental species for investigation the growth of fish in intensive culture system in concrete tanks by using floating feed.

The aquaculture development and increase in per unit volume of water depends after all artificial feed [4]. Among cyprinids, rohu (*Labeo rohita*) is the most popular fish species which is cultivated in Indian subcontinent. Rohu is considered as the delicious and prestigious fish species among other Indian major carps for its uniqueness and attributes [5]. Tilapia is very resilient species which may reduce the gap of accelerating worldwide demand for its protein sources and market demand [6]. The use of commercial feed has become a time demanded initiative for the success of cyprinid culture and tilapia under intensive culture conditions particularly rohu along with other carps [7] and tilapia monosex culture.

In the 21st Century, water resources will be at a premium, with water shortages expected after 2025. With such a pressure on this vital resource for aquaculture it will no longer be possible due to the lack of water sources. Competition for this resource will increase with drinking water shortage expected to affect large populations by 2025. This important constraint will have a major bearing on how aquaculture can and will develop in the new millennium, and appropriate technologies and farming systems will be required to address this issue. Shortage

of water will become a limiting factor in many areas. Ponds must become more “intensive” with respect to water use (e.g., tank-based intensive culture of fish). Aquaculture ponds can be integrated into water conservation and management systems and tank culture can be an effective way of overcoming the problem of water shortages. These improved methods of tank based intensive aquaculture of tilapia is an efficient way to utilize scarce water resources effectively and farmers will get higher production in a small parcel of land.

This study aimed to specify the comparative growth performance, yield and FCR to make a rational decision for get better outcomes from tank-based intensive aquaculture system with the economic affordability of fish farmers. The study finds out the growth performance, production and Feed Conversion Ratio (FCR) of rohu and tilapia focusing on different intermediate sampling stages to have better understanding on growth trends. This culture system may be an applauding way of producing fish in a small parcel of land within a short cycle.

Materials and methods

Experimental site

Concrete made squared shaped tanks under a properly constructed shed were established in the backyard (south of the wet laboratory complex) of the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh. Water supply and exchange facility was also satisfactory there. Each tank is of length 1m, width 1m and depth 1.2 m and water volume in each tank was $1 \times 1 \times 1 = 1\text{m}^3$. Among the six tanks, three tanks were used to study the growth, yield and survival of rohu (*Labeo rohita*) and remaining three tanks used to observe the consecutive performance of tilapia (*O. niloticus*) in intensive rearing system. Both the fish species was fed with floating to have better understating in various sampling stages.

Experimental tanks

For conducting the experiment, six concrete tanks were used. The bottom of the tank was made smooth and coated with white cement to make the bottom visible and facilitate the cleaning process easily. The outlet pipes of the tanks were closed to prevent water leakage. Siphoning process was followed to clean the tanks. Water was supplied from a deep tube well located near the experiment site.

Experimental design and layout

Mono sex male tilapia (*O. niloticus*) fry was used as experimental species. For the experiment, two treatments were designed namely T_1 and T_2 and there were three replications for each. Fry was released at the rate of 8 fry per tank that equivalent to the stocking density of 320 fish per decimal or about 80,000 per hectare with different average initial weight for six tanks individually Table 1, Figure 1.

Selection of feed and feeding frequency

The fishes were fed commercial floating feed named as ‘Mega Feed’ and ‘Quality Feed’ for T_1 and T_2 , respectively. In first 30 days of the experiment, the size of floating feed used



for feeding the fish was 0.25 mm. Then the pellets of 0.5 mm were used to feed the fish during the rest experimental period. During experimental period feed was given at the rate of 20%, 15%, and 10% of the body weight in 1st, 2nd and 3rd month, respectively Table 2.

Feeding strategy

The daily ration of fish was adjusted with the body weight. The total amount of ration was divided into two parts and half was supplied to the fish in the morning (9:30am) and the rest half was delivered in the afternoon (4:30pm). During experimental period, there were three replications for each treatment and feed was supplied at the rate of 12%, 8%, and 4% and 20%, 15%, and 10% of the body weight in 1st, 2nd and 3rd month for T₁ and T₂, respectively. The daily ration was calculated as the following rate in the Table 3.

Sampling of fish

Fish sampling was done by catching all fishes of individual tanks at three days interval. Fishes were caught by using small triangle shaped push net (Figures 2,3). The weighing process was done by an electric balance (MODEL: HKD-620AS-LEDE) in gram. The length was recorded by measuring scale in cm (Figure 3). Sampling was performed in the morning at around 9:00 am prior to delivering feed to observe growth and health conditions.

Aeration installation

Air stone aerators were applied to provide sufficient oxygen powered by electricity. A single air stone was allocated for each tank. The aerator motors were attached with the main structure of the roof of the shed. The aeration was operated for 24 hours during the experimental period.

Study of growth parameters of fish

For evaluating the growth of fish, different growth

Table 2: Ingredients and proximate composition of the experimental diets.

Proximate composition	T ₁	T ₂
	Floating feed (%)	Floating feed (%)
Moisture	12	10
Protein	32	28
Fat	5	6
Starch	27	22
Fiber	9	3
Ash	12	12
Calcium	2	2
Phosphorus	1	1

Table 3: Feeding chart for the experimental fish.

Days	Amount of feed (% of the total body weight of fish)	
	T ₁	T ₂
1 st 30 days	12%	20%
2 nd 30 days	8%	15%
Final 30 days	4%	10%



Figure 2: Sampling and weighing of fish *Labeo rohita* and *Oreochromis niloticus*.

Table 1: Design and layout of the experimental tank.

Intensive Culture Unit					
T ₁			T ₂		
Replication	Stocking density (fry/tank)	Average initial weight (g)	Replication	Stocking density (fry/tank)	Average initial weight (g)
R ₁ (tn ₁)	8	6.52	R ₁ (tn ₄)	8	15.92
R ₂ (tn ₂)		9.62	R ₂ (tn ₂)		14.61
R ₃ (tn ₃)		6.42	R ₃ (tn ₆)		13.72



Figure 1: Experimental concrete made tank.



Figure 3: Digital DO meter.

parameters such as length gain (cm), weight gain (g), percent (%) weight gain, specific growth rate (SGR % per day) and production (kg/ha/100 days) were taken into consideration and were measured using the following formula. The length and weight of fish were measured using centimeter scale and electric balance (Model; HKD-620AS-Led) in grams.

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

$$\text{Percent (\%)} \text{ weight gain} = \frac{\text{Mean final weight (gm)} - \text{Mean initial weight (gm)}}{t(\text{days})}$$

$$\text{SGR (\%)} \text{ per day} = \frac{\log W_2 - \log W_1}{T_2 - T_1} \times 100$$

Feed conversion ratio (FCR) = Total amount of feed consumed (gm)/ Wet weight gain (gm)

$$\text{Daily weight gain (DWG)} = \frac{\text{Mean final weight} - \text{Mean initial weight (gm)}}{\text{Mean initial weight (gm)}} \times 100$$

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

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

Study of water quality parameters

During the experimental period, water quality assessment of the experimental tanks were recorded very intensively two times daily. Water quality parameters especially temperature, DO, pH was measured in the morning and afternoon daily and all the tests were performed in the experimental shed. Different physio-chemical parameters including DO was measured using digital DO meter (Model: CE 225908) in mg/l. Water temperature was measured by using digital thermometer (model: CE 225908) in °C and pH was recorded by digital pH meter (Model: CE 224469).

Data analysis

Collected fish growth and water quality data were recorded in MS Excel 2010. Statistical analysis was done to evaluate the effect of the two treatments (T_1 and T_2) on the growth of fish were significant or not. Independent sample T-Test was performed to test the significance of difference among different water quality parameters. The entire statistical test was conducted by using SPSS (Statistical Package for Social science) version 16. The graph was prepared by using both MS Excel and SPSS. In compliance with the guidelines for fish research approved by the animal ethics committee, fish experiment was conducted in twelve concrete tanks under an outdoor laboratory shed from 10 May–29 July, 2019.

Results

Fish growth performance

Final weight: The initial weight of individual was 7.52 ± 1.81 gm and 14.75 ± 0.19 gm for T_1 and T_2 , respectively. The final mean weight of fish was 44.01 ± 5.65 g for T_1 and 139.94 ± 1.29 for T_2 , respectively with no significant difference ($p < 0.05$) between the treatments Table 4.

Weight gain: This controlled experiment was conducted to assess the growth of tilapia frequently in 3 days interval. In this study, the average weight gain of tilapia for T_1 was 36.49 ± 4.09 gm and for T_2 was 125.19 ± 1.29 g, respectively. The difference in weight gain is notably remarkable between two treatments.

The weight gain of tilapia was higher in T_2 than T_1 (Table 5). In term of weight gain, in the most sampling stages, the performance in T_2 was significantly ($p < 0.05$) higher than T_1 . In term of growth trend, after about a month, the different trend of weight gain was observed. The higher weight gain in T_2 was observed from the 5th sampling. However, it was remarkable increment growth after about a month.

Percent weight gain (%): The mean percent weight gain was higher in T_2 (1715.05 ± 0.00) than T_1 (485.23 ± 0.00). The higher percent weight (1715.05%) was found in T_2 where fishes were fed at the rate of 20%, 15%, and 10% of the body weight in 1st, 2nd and 3rd month with average individual weight of 14.75 ± 0.19 gm (Figure 4).

Feed Conversion Ratio (FCR)

The feed conversion ratio was calculated taking the total feed used into consideration in the experiment. Feed conversion ratio values of floating feed used for feeding the fish in T_1 and T_2 , respectively were 2.86 ± 0.14 and 2.23 ± 0.18 (Figure 5).

Table 4: Growth parameters (mean ± SD) after twelve (12) weeks of feeding.

Growth parameters	T_1	T_2
IBW (gm)	7.52 ± 1.81	14.75 ± 0.19
FBW (gm)	44.01 ± 4.03	139.94 ± 1.29
WG (gm)	36.49 ± 4.09	125.19 ± 1.29
% WG	485.23 ± 0.00	1715.05 ± 0.00

IBW (gm)= Initial weight, FBW (gm)= Final weight, WG (gm)=Weight gain

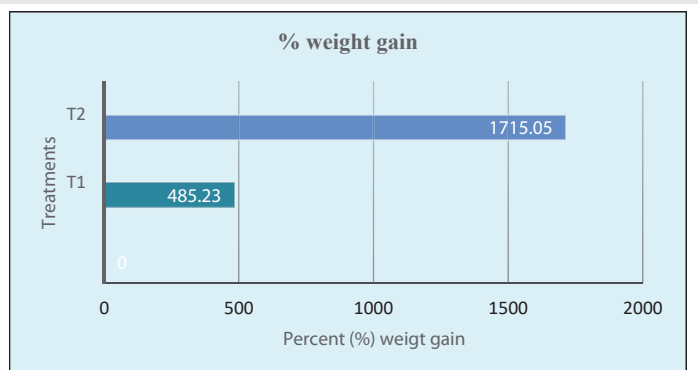


Figure 4: Percent (%) weight gain (T_1 and T_2).

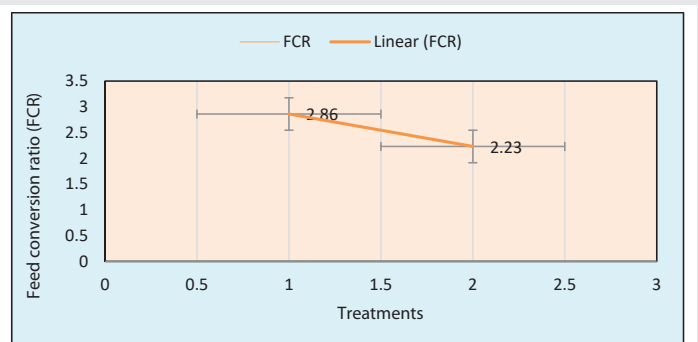


Figure 5: Feed conversion ratio in (T_1 and T_2).



Specific Growth Rate (SGR % per day)

The specific growth rates (SGR) of T_1 and T_2 were found 4.98 ± 2.28 and 6.26 ± 3.83 , respectively. There was significant difference ($p > 0.05$) in term of SGR between the treatments. The present study determined the percentage growth rate in different sampling stages more frequently which are generally not determined considering the initial and harvesting weight data, and the intermediate data are excluded. For this reason, the fishes were sampled to gain the weight of fish to determine the actual growth performance at particular sampling stages. In this regard, in first month of the production cycle the growth of T_2 was higher than that of T_1 . The SGR of T_2 was shown increasing gradually. After that, at the last sampling stage, average trend of SGR was observed (Figures 6-8). More specifically, the significant higher specific growth rates were observed at the middle stage (In between 4th June and 18th June) of the experiment and also in later stages (Table 5, Figure 6).

Total production (g/cm³)

The total productions at the end of the study were $278.19 \pm 0.00g$ and $1119.52 \pm 0.00g$ per cm³ in T_1 and T_2 , respectively (Figure 9). The production was higher in the tanks fed with 20%, 15%, and 10% of the body weight.

Water quality parameters

The mean values of tested water quality parameters such as temperature and DO of the experimental ponds are presented in Table 6. There was no significant difference ($p < 0.05$) in the temperature in morning and evening in both treatments. The

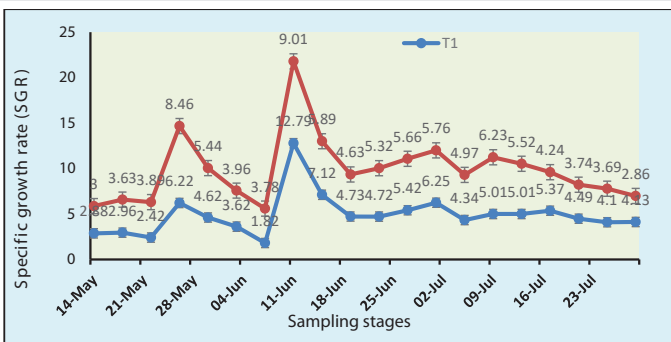


Figure 6: Specific growth rate at various sampling stages.

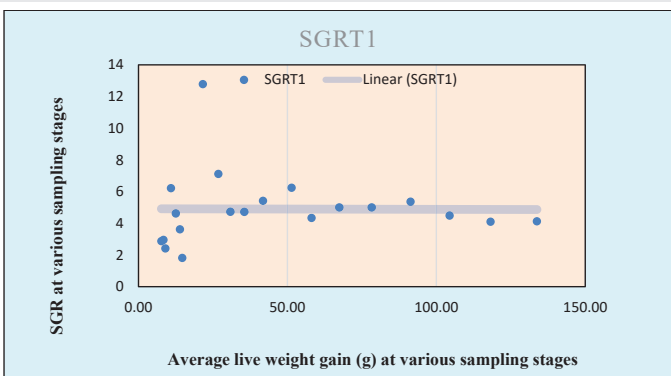


Figure 7: Specific growth rate of rohu (T₁).

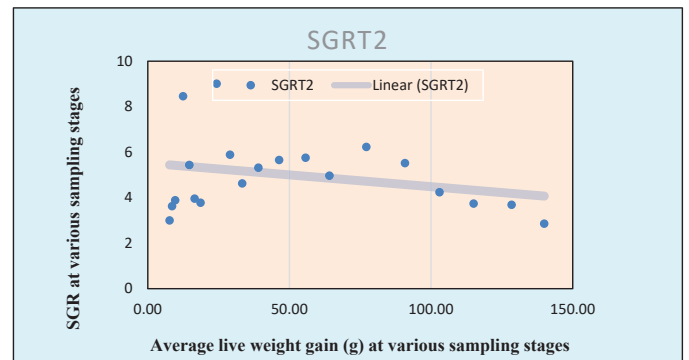


Figure 8: Specific growth rate of tilapia (T₂).

Table 5: Specific Growth Rate (SGR) at 3 days interval.

Sampling No.	Sampling day/stage	Average SGR in Treatment 1 (Mean ±SD)	Average SGR in Treatment 2 (Mean ±SD)
01	14 May, 19	2.88±0.382	3.00±0.562
02	18 May, 19	2.96±2.491	3.63±1.204
03	22 May, 19	2.42±1.665	3.89±2.784
04	26 May, 19	6.22±3.029	8.46±2.099
05	30 May, 19	4.62±0.411	5.44±0.479
06	03 Jun, 19	3.62±1.957	3.96±1.335
07	07 Jun, 19	1.82±0.585	3.78±1.781
08	11 Jun, 19	12.79±1.708	9.01±3.120
09	15 Jun, 19	7.12±3.938	5.89±2.173
10	19 Jun, 19	4.73±0.975	4.63±0.297
11	23 Jun, 19	4.72±1.918	5.32±1.109
12	27 Jun, 19	5.42±0.816	5.66±0.706
13	01 July, 19	6.25±7.144	5.76±5.729
14	05 July, 19	4.34±2.391	4.97±1.786
15	09 July, 19	5.01±1.667	6.23±1.299
16	13 July, 19	5.01±1.582	5.52±1.251
17	17 July, 19	5.37±3.433	4.24±0.667
18	21 July, 19	4.49±1.569	3.74±1.623
19	25 July, 19	4.10±0.542	3.69±0.610
20	29 July, 19	4.13±0.621	2.86±0.595

difference of dissolved oxygen content was very low between two treatments. The dissolved oxygen contents in both treatments were similar because aerators were installed in all the tanks.

Discussion

In this present study, the difference in weight gain was found between the treatments. The mean initial weight of the rohu in the 3 tanks of T_1 was 7.52 ± 1.81 and in the other 3 tanks of T_2 was 14.75 ± 0.19 . At the end of the experiment, the mean final weight of the fish in T_1 was 44.0177 ± 4.03 and 139.94 ± 1.29 in T_2 . The mean final weight gain was 36.49 ± 4.09 and 125.19 ± 1.29 in T_1 and T_2 , respectively. The weight gain was higher in T_2 which might be due to the fact that fish had taken more amount of feed in almost similar level of water quality [8].

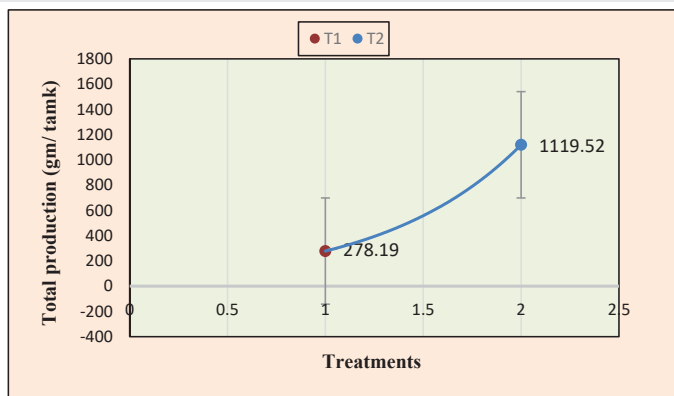


Figure 9: Total production of tilapia in the two treatments (T₁ and T₂).

Table 6: Water temperature of experimental tanks.

Water quality parameters	Treatments	Morning	Evening
Temperature (°C)	T ₁	27.19 ±1.46	28.23±1.58
	T ₂	28.54±1.43	28.65±1.67
DO (mg/l)	T ₁	5.58 ±0.82	6.15 ±0.65
	T ₂	5.85 ±0.85	6.58±0.82

To evaluate the utilization of feed, Feed conversion ratio (FCR) was calculated that was given to the fish as feed supplement. The expected FCR for tilapia ranges from 1.5 to 2.0 [9]. The FCR in present study were 2.86 ± 0.14 and 2.23 ± 0.18 in T₁ and T₂, respectively. The FCR in T₂ was within expected range but in case of T₁, it was higher than the accepted value. In this experiment, feed was given following general method of percentage body weight consideration, not considering the satiation level. For this, the supplied feed might remain unused. That is why the feed conversion ratio (FCR) of T₁ was higher than expected level as the total amount of delivered feed was taken into consideration during calculating the FCR [10].

The survivability of rohu and tilapia in the present study was 100%. Ahmed, *et al.* [11] recorded survival rate of tilapia ranged from 82 to 90%. In this study, the highest survivability might be the cumulative result of good water quality parameters due to weekly water exchange, quality feed uses and proper maintenance during culture. This result of 100% survival in both the treatments confirms that indoor tank-based aquaculture systems can be developed in Bangladesh where land is getting scarce natural resource.

The mean total production per cm³ was 278.19 gm and 1119.52 g in T₁ and T₂, respectively. The production was higher in T₂ than T₁. Roy [12] stated that the production of GIFT tilapia under different stocking density such as 80, 120 and 160 fish/decimal with feeding 30% protein containing diet at a rate 3–5% body weight were 9.04, 11.97 and 13.91 kg/decimal, respectively. He showed that, the best individual weight gain of fish was 104 gm. In the present study, the production was higher than the finding of Roy [12] if the culture area of tank were corresponded to hectare. The fact of higher production might that the initial weigh of the T₂ was than T₁ and may be this size group of tilapia prefers and consume more floating feed than the rohu [13]. But the growth performance in relation to FCR was higher in T₂ than T₁.

Shaha, *et al.* [14] reported that the water quality parameters for fish culture i.e., temperature 22.6 to 32.5°C, dissolved oxygen 4.3 to 6.8 mg/l. It is very important to maintain the temperature of the culture unit. The suitable range of tilapia culture is 26 to 32°C [15]. The body temperature of fish is related to water temperature, and growth, reproduction and other biological activities are influenced by the temperature largely. The water temperature of the experimental tanks was within the suitable range of tilapia culture. The average value of temperature in T₁ was 27.19 ± 1.46 and 28.23 ± 1.58 during morning and evening, respectively. In T₂, the mean temperature was 28.54 ± 1.43 and 28.65 ± 1.67 in morning and evening, respectively.

Islam [16] reported that tilapia can tolerate dissolved oxygen concentration as low as 0.1 mg/l. Higher level of dissolved oxygen concentration was recorded in the experimental tanks as a result of aerator installation. In the present study, the mean average oxygen content of T₁ was 5.58 ± 0.82 and 6.15 ± 0.65 during morning and evening, respectively. In T₂, the mean dissolved oxygen content was 5.85 ± 0.85 and 6.58 ± 0.82 in morning and evening, respectively. Tilapia can survive at very low dissolved oxygen content [17–19].

Conclusion

This experiment had an introspective observation to detect consecutive growth performance and yield in relation to FCR. This study finds out an outstanding clarification on the growth performance (T₁ and T₂) in different sampling stages in relation to supplied feed at various stages of fish growth. It was observed that total production was increased with the increase of stocking density. Overall, this study suggests that tank-based aquaculture can be developed in the indoor system that can ensure 100% survival. This study reveals an outstanding clarification on the growth performance of fish in different sampling stages. From the experiment, it might be suggested that the higher stocking density (320 fish per decimal) performed the better results in T₂ than T₁. It is possible to produce a higher number of fish in such a improved way from a small parcel of land within a short cycle. However, further study needed to explore the relative cost effectiveness of the culture of rohu and tilapia fish in higher stocking density in tank-based aquaculture system. This study will assist the researchers and academicians who wants to culture rohu and tilapia in intensive aquaculture system by using floating feed.

Authors contribution

The work was carried out in collaboration between both authors. Both authors read and approved the manuscript.

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