



## STUDIES ON THE GROWTH AND PRODUCTION PERFORMANCE OF ROHU (*LABEO ROHITA*) AT DIFFERENT STOCKING DENSITIES IN INTENSIVE AQUACULTURE SYSTEMS USING FLOATING FEED

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**Abstract:** The study was conducted to assess the growth and production of rohu (*Labeo rohita*) in intensive aquaculture system in relation to feed conversion ratio (FCR). To assess the weight gain, SGR and FCR, the experiment was performed in six concrete tanks under a shed located on the southern corner of Faculty of Fisheries, BAU for 100 days from 26<sup>th</sup> June to 3<sup>rd</sup> September, 2018. Rohu fry was released at the rate of 4 fry per tank equivalent to the stocking density of 160 fishes/decimal for treatment 1 T<sub>1</sub> and at the rate of 8 fry per tank equivalent to the stocking density of 320 fishes/decimal for treatment 2 T<sub>2</sub>. Floating feeds were used for feeding the fish in both treatments. There were three (3) replications for each treatment. During experimental period, feed was given at the rate of 12%, 8%, and 4% of the body weight in first 30 days, second 30 days and final 40 days, respectively. The weight gains of fish were 42.89±1.509 g and 23.49±4.039 g for T<sub>1</sub> and T<sub>2</sub>, respectively. The mean percent weight gain of rohu was higher in T<sub>1</sub> (588.12±0.00) than T<sub>2</sub> (319.29±0.00). Feed conversion ratio (FCR) in T<sub>1</sub> and T<sub>2</sub> were 2.21 and 2.99, respectively. The specific growth rate (SGR) of rohu in T<sub>1</sub> and T<sub>2</sub> were 1.92±0.275 and 1.43±0.108, respectively. The SGR for T<sub>1</sub> was higher and FCR was lower in production cycle than T<sub>2</sub>. The total production was obtained 201.56±0.00 g in T<sub>1</sub> and 248.08±0.00 g in T<sub>2</sub>, respectively with 100% survival rate in both the treatments.

**Keywords:** Aquaculture, Intensive floating feed, *Labeo rohita*, Specific growth rate.

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### INTRODUCTION

Fish and fisheries sectors play a significant role in our national economy, nutrition, employment generation, income and also help a lot of foreign

exchange earnings. The growth of fisheries sector in Bangladesh is increasing day by day and contributes about 25.72% to the agricultural GDP (DoF, 2020). 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. Aquaculture, the fastest growing food producing sector in the world and plays a significant role in the socio-economic development of many countries in view of its potential contribution to national income, nutritional security, social objectives and sustainable large export earnings. As the population of Bangladesh is increasing day by day, the open water resources is declining and enhancement of wild fish production from rivers, canals and estuary is quite difficult (Chakraborty *et al.*, 2021; Chakraborty and Mome, 2022).

In Bangladesh, conventional semi-intensive aquaculture system is generally followed in case of fish culture besides extensive system. However, land area is declining and the competition between aquaculture and other agricultural sectors is increasing in the context of land and water use. Therefore, intensive aquaculture is growing to enhance national fish production in the context of population growth and declining land resource that is required to construct ponds (Rahman and Arifuzzaman, 2021a). This system requires ample supply of good quality water. Less land is required to produce the same quantity of fish as compared to extensive and semi-intensive systems. The systems employ mainly raceways, various types of tanks and floating cages as holding units. In these systems, more fish are produced per unit area by complementing or substituting the natural productivity in the culture units by exogenous feeding using complete feeds and water aeration.

The production of fish by intensive system depends on the management levels employed by individual producers. This production can go higher with better management and quality feeds. The higher stocking density makes it possible to obtain a large yield even from a small parcel of land. Intensive aquaculture relies on technology to raise fish in artificial tanks or ponds at very high densities and high feed supply in limited areas and these culture systems are generally established in the areas where there is a large

quantity and good quality flowing water. Moreover, fish production per unit area is found much higher in intensive aquaculture systems compared to semi-intensive and extensive systems (Chakraborty, 2020, 2021). To fulfill the animal protein demand for teeming 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 (DoF, 2020).

The present study has taken rohu as an experimental species for investigation the growth of fish in intensive culture system in concrete tanks by using floating feed. The use of commercial feed has become inevitable for the success of cyprinid culture under intensive culture conditions particularly rohu along with other carps (Abid and Ahmed, 2009). There is no research of rohu in intensive aquaculture using floating feed. Because of the lack of adequate information about the efficacy of market available floating feed for the intensive aquaculture of rohu. Therefore, the study was conducted to find out the utilization of commercial floating feed in the growth performance of rohu and to assess specific growth rate (SGR) focusing on different intermediate sampling stages to have better understanding on growth trends.

## MATERIALS AND METHOD

### Study site

In order to perform the experiments, concrete made squared shaped tanks were constructed in the backyard (south of the wet laboratory complex) of the Faculty of Fisheries, Bangladesh Agricultural University (BAU), Mymensingh (Fig.1). There were twelve tanks under the properly constructed shed (Fig. 1). The security measures were properly managed so that any external agents could not disturb or hamper the culture system. Water supply and exchange facility was also satisfactory there. The diameter of each tank is 1m length, 1m width and 1m depth and water volume in each tank was  $1 \times 1 \times 1 = 1 \text{ m}^3$ .

Among the twelve tanks, six tanks were used to study the growth and production of rohu (*Labeo*



**Fig.1: Experimental site at BAU, Mymensingh (Bangladesh).**

*rohita*) in intensive rearing in concrete tanks. The study was carried out for a period of 100 days from 26<sup>th</sup> June to 3<sup>rd</sup> September, 2018. Rohu was fed with floating feed to develop better understanding on the growth performance and its subsequent SGR.

**Experimental tanks**

Six tanks were used for conducting the experiment, each tank 1 m<sup>3</sup> made of bricks, sand and cement. The bottom was 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 experimental site.

**Experimental design and layout**

Rohu fry was used as experimental species. For

the experiment, two treatments were designed namely T<sub>1</sub> and T<sub>2</sub> and there were three replications for each treatment. The stocking density of rohu fry per m<sup>3</sup> was 4 and 8 for treatment T<sub>1</sub> and T<sub>2</sub>, respectively. The tanks of T<sub>1</sub> and the tanks of T<sub>2</sub> were treated with floating feed. Fry was released at the rate of 4 fry per tank that equivalent to the stocking density of 160 fish per decimal equivalent to about 40,000 per hectare. In T<sub>2</sub>, 8 fry per tank that equivalent to the stocking density of 320 fish per decimal or about 80,000 per hectare were released.

**Aeration Installation**

A blower machine (Model: TP GHS-3326) was installed in the experimental shed for aeration of the tanks, which was powered by electricity and operated by timer machine for ensuring continuous periodical aeration (Fig. 2). The



**Fig. 2: (A). Blower machine.**



**Fig. 2: (B) Timer machine.**

### Sampling of fish

Fish sampling was done by catching all fishes of individual tanks at ten days interval. Fishes were caught by using small triangle shaped push net. The weighing process was done by an electric



balance (MODEL: HKD-620AS-LEDE) in gram (Fig.3). The length was recorded by measuring scale in cm (Fig. 3). Sampling was performed in the morning at around 9:00 am prior to delivering feed to observe growth and health conditions.



**Fig. 3: Sampling and weighing of fish studied.**

### Study of growth parameters of fish

For evaluating the growth of fish, different growth 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 formula given. The length and weight of fish were measured using centimeter scale and electric balance (Model; HKD-620AS-Led) in grams.

$$\text{Percent (\%)} \text{ weight gain} = \frac{A-B}{B} \times 100$$

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

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

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

### Study of water quality parameters

Water quality parameters of the experimental tanks were recorded very intensively two times daily throughout the entire study period. Water quality parameters especially temperature, DO, pH were measured in the morning and afternoon daily and all the tests were performed in the experimental shed. Different physico-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 (sinking and floating feed) on the growth of fish, whether significant or not. 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.

## RESULTS

### Fish Growth Performance

#### Final Weight

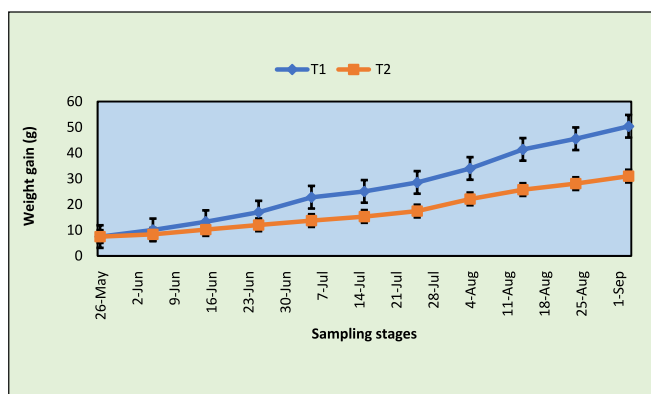
The initial weight of individual rohu was  $7.50 \pm 1.604$  g and  $7.52 \pm 1.819$  g for  $T_1$  and  $T_2$ , respectively. The difference in initial weight between two treatments was not significantly remarkable. The final mean weight of each fish was  $50.39 \pm 1.509$  g for  $T_1$  and  $31.01 \pm 4.039$  g for  $T_2$ , respectively having significantly different ( $p < 0.05$ ) between the two treatments.

#### Weight gain

Average weight gain of rohu for  $T_1$  was

42.89±1.509 g and for T<sub>2</sub> was 23.49±4.039 g. The difference in weight gain was notably remarkable between two treatments. The weight gain of rohu was higher in T<sub>1</sub> than T<sub>2</sub> having significantly different (p<0.05) between the two treatments. This controlled experiment was conducted to assess the growth of rohu frequently in 10 days interval. This frequent observation was done to find out where the maximum growth was taken place in the production cycle of 100 days in two different stocking densities. In term of weight gain, in the most sampling stages, the performance in T<sub>1</sub> was significantly higher than T<sub>2</sub>. In term of growth trend, after about a month, the different trend of weight gain was observed (Fig. 4).

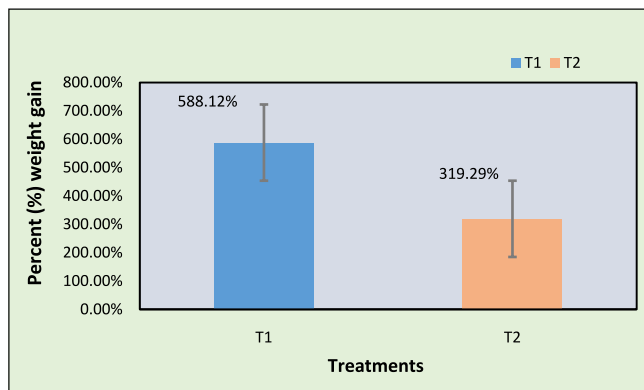
In most of the sampling stages, there was significant difference (p<0.05) in terms of average weight gain at 10 days interval between the two treatments that was identified by independent samples test. The average weight gain was not significantly different (p>0.05) between the treatments up to 30 days since starting of the experiment. It was observed that weight gains of rohu were increasing linearly all the way through the culture period from first sampling to final sampling (Fig. 4).



**Fig. 4: Variation of weight gain of rohu in two treatments.**

**Percent weight gain (%)**

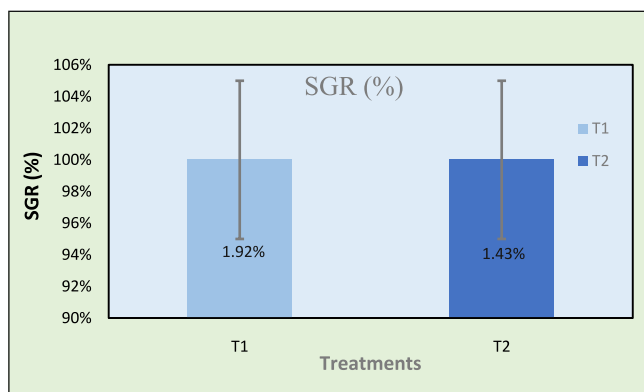
The mean percent weight gains of fishes were 588.12±0.00 and 319.29±0.00 for the treatment T<sub>1</sub> and T<sub>2</sub> respectively (Fig. 5). The higher percent weight (588.12%) was found in T<sub>1</sub> where fishes are stocked at low stocking density and lower (319.29%) was in T<sub>2</sub> where fishes are stocked at high stocking density. The percent weight gain of rohu was significantly different (p<0.05) between the two treatments.



**Fig. 5: Percent weight gain of rohu in two treatments.**

**Specific growth rate (SGR % per day)**

The specific growth rates (SGR) of rohu in T<sub>1</sub> and T<sub>2</sub> were found 1.92±0.175 and 1.43±0.108, respectively (Fig. 6). There was significant difference (p<0.05) in term of SGR between two treatments).



**Fig. 6: Percent specific growth rate of rohu in the treatment T<sub>1</sub> and T<sub>2</sub>.**

The present study was carried out to reveal the points of specific growth rate (SGR) in different stages of the growth of rohu. These were generally not properly determined by considering the initial and harvesting weight data; the intermediate data are excluded in calculation and intermediate the specific growth rate trend remains poorly understood. For this reason, the fishes were sampled at 10 days interval to gain the weight of fish to determine the SGR at particular point of growth more specifically. In this regard, in the production cycle, the SGR of T<sub>1</sub> was higher than that of T<sub>2</sub> in the most of the sampling stages (Table 1).

There was a significant difference (p<0.05) found at first and fourth sampling stage during the

experiment (Table 1). More specifically, the significant higher specific growth rates were observed in early stages of the experiment particularly in case of T<sub>1</sub> (low stocking density) of rohu. The SGR at the initial stage was started from

the higher range in T<sub>1</sub> compared to T<sub>2</sub>. In case of T<sub>1</sub>, the specific growth rate at the early stages of the experiment was higher and then decreased (Fig.7). For the T<sub>2</sub>, the specific growth rate in all sampling stages was near to the mean values (Fig. 8).

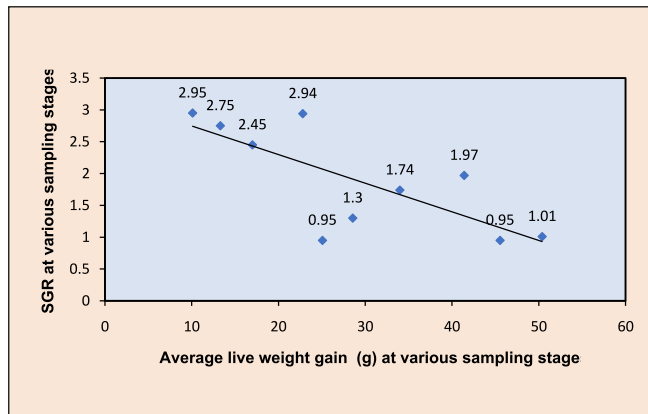


Fig. 7: Specific growth rate of rohu at low stocking density T<sub>1</sub>.

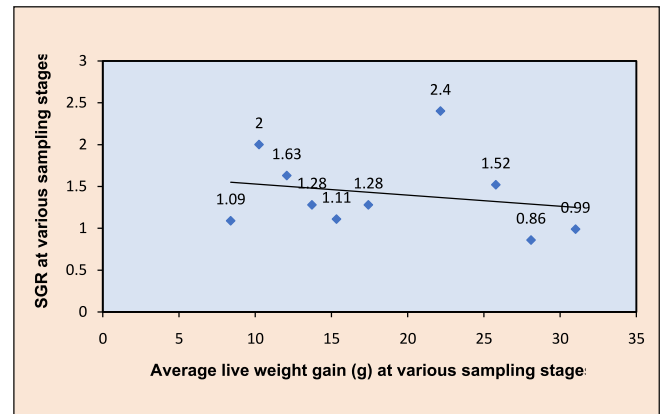


Fig. 8: Specific growth rate of rohu at high stocking density T<sub>2</sub>.

Table 1: Specific growth rate (SGR) at 10 days interval.

Sampling No.	Sampling day/stage	Average SGR in Treatment 1 (Mean ± SD)	Average SGR in Treatment 2 (Mean ± SD)	Significant level (p value)	Comments
01	05 Jun, 18	2.95 ± 1.838	1.09 ± 0.615	0.006	Significant
02	15 Jun, 18	2.75 ± 2.263	2.00 ± 1.315	0.200	Insignificant
03	25 Jun, 18	2.45 ± 2.616	1.63 ± 1.287	0.149	Insignificant
04	05 Jul, 18	2.94 ± 4.101	1.28 ± 1.667	0.027	Significant
05	15 Jul, 18	0.95 ± 1.605	1.11 ± 1.138	0.599	Insignificant
06	25 Jul, 18	1.30 ± 2.468	1.28 ± 1.478	0.948	Insignificant
07	04 Aug, 18	1.74 ± 3.839	2.40 ± 3.345	0.224	Insignificant
08	14 Aug, 18	1.97 ± 5.239	1.52 ± 2.567	0.260	Insignificant
09	24 Aug, 18	0.95 ± 2.927	0.86 ± 1.633	0.630	Insignificant
10	03 Sep, 18	1.01 ± 3.429	0.99 ± 2.064	0.864	Insignificant

**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<sub>1</sub> and T<sub>2</sub>, respectively were 2.21 and 2.99 (Fig. 9). The feed conversion ratio (FCR) of rohu was significantly different (p < 0.05) between the two treatments.

**Total production (g/cm<sup>3</sup>)**

The total productions of rohu at the end of the study (after 100 days) were 201.56 ± 0.00 g and 248.08 ± 0.00 g per tank in T<sub>1</sub> and T<sub>2</sub>, respectively (Fig. 10). The production was higher in the tanks where rohu was stocked at high stocking density (T<sub>2</sub>) than where rohu was stocked at low stocking density (T<sub>1</sub>). There was no significant difference (p > 0.05) in term of total production of rohu between two treatments.

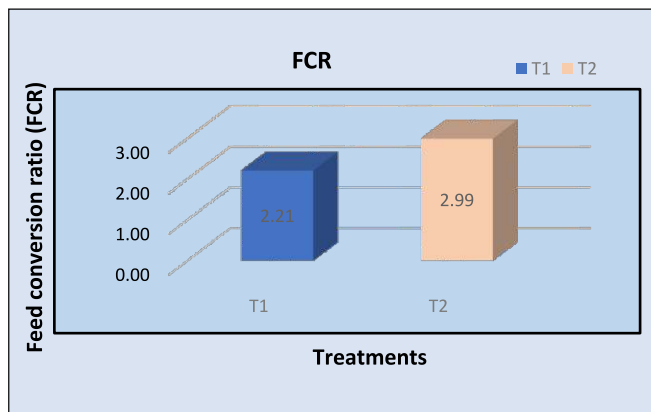


Fig. 9: Feed conversion ratio of T<sub>1</sub> and T<sub>2</sub>

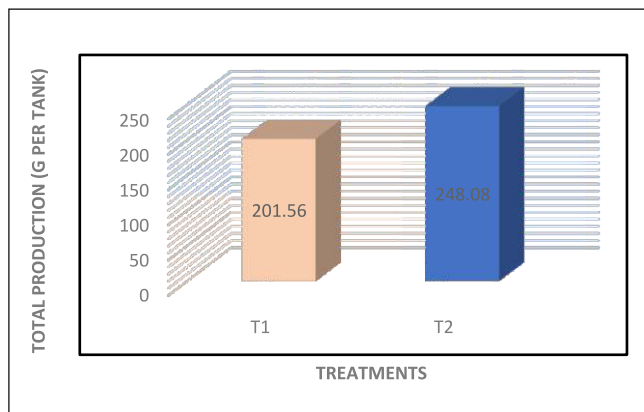


Fig.10: Total production of rohu in the two treatments (T<sub>1</sub> and T<sub>2</sub>).

**Water quality parameters**

The mean values of tested water quality parameters such as temperature, DO and pH of the experimental tanks are presented in Table 2.

There was no significant difference ( $p > 0.05$ ) of the two treatments among the mentioned parameters.

**Table 2: Various water quality parameters (mean ± SD) in two different treatments.**

Treatments	Dissolved Oxygen (mg/l)	Temperature (°C)	pH
T <sub>1</sub>	6.46 ± 0.159	27.48 ± 0.397	8.39 ± 0.177
T <sub>2</sub>	6.48 ± 0.130	27.49 ± 0.392	8.39 ± 0.175

**DISCUSSION**

The present study aimed to find out the crucial points in the growth of fish and to adjust the right amount of required quality feed to reduce the wastage of feed. If the wastage can be reduced the water quality of culture systems will also be improved. At the same time the cost of feed will also be minimized at the farmer's level.

system, stocking density and also difference for the aeration facilities.

In this present study, the fishes were fed commercial floating feed in treatment 1 T<sub>1</sub> and treatment 2 T<sub>2</sub>. The difference in weight gain was found between the treatments. The mean weight gain was 42.89 ± 1.509 g and 23.49 ± 4.039 g in T<sub>1</sub> and T<sub>2</sub>, respectively. The weight gain was higher in T<sub>1</sub> in almost similar level of water quality than T<sub>2</sub> which might be due to the lower stocking density. The mean weight gain of rohu in T<sub>1</sub> and T<sub>2</sub> of the present study is higher than the highest weight gain of rohu (23.53 ± 6.84 g) fed with floating feed in carp polyculture for 90 days (Khan, 2013). This is due to the different culture

Specific growth rate of rohu in intensive tank aquaculture system was the main fact of interest of the present study. In usual way, specific growth rate is calculated using the data of initial and final weight but the intermediate data is not considered. Therefore, from that result, the important stages of the growth of fish is not possible to understand properly. To avoid this gap, the weight of fish was taken after 10 days interval in this experiment. The mean value of SGR in T<sub>1</sub> and T<sub>2</sub> were 1.92 ± 0.00 and 1.43 ± 0.00, respectively. From these data, it was found that the specific growth rate of rohu in T<sub>1</sub> was higher than in T<sub>2</sub> in first 40 days (around) and in the middle stage both SGR was more or less similar. The SGR of rohu in T<sub>1</sub> was initially higher than T<sub>2</sub> and the value decreased in both the treatments, respectively. The lowest value of SGR in T<sub>1</sub> and T<sub>2</sub> were recorded in 24<sup>th</sup> August (Table 1). On the

other hand, the value of SGR in T<sub>2</sub> was higher in 4<sup>th</sup> August than T<sub>1</sub> (Table 1). The trend lines of both SGR were also in downward direction at the end of the experiment. However, it requires further research for a long duration in different seasonality to unpack the fact. Rahman *et al.* (2006) recorded mean SGR value as  $1.44 \pm 0.52$  in rohu monoculture system, was lower than the present mean SGR value.

The FCR of rohu in present study were 2.21 and 2.99 in T<sub>1</sub> and T<sub>2</sub>, respectively. The FCR in T<sub>1</sub> was within expected range but in case of T<sub>2</sub>, it was higher than the accepted value. In this experiment, feed was given following general method of body weight percentage consideration, not considering the satiation level. For this, the supplied feed might remain unused. For this reason, the feed conversion ratio (FCR) was higher than expected level as the total amount of delivered feed was taken into consideration during calculating the FCR (Rahman *et al.*, 2022). Calculation of traditional SGR using the data at the beginning and end of the culture period, weight gain and FCR did not indicate the efficient and economic use of feed and production of fish. Therefore, determining SGR in a specific interval at least 15 days interval might be the practice for rohu farmers (Rahman and Islam, 2021).

The survival rate of rohu in the present study was 100%. Rafique (2013) recorded the mean survival rate of rohu varied from 93.13 to 98.13%. Wahab *et al.* (1995) found survival rate above 85% of all fish species in polyculture of Indian major carps. In this study, the highest survivability might be the cumulative result of good water quality parameters due to weekly water exchange, quality feed use, and proper maintenance during culture (Rahman and Arifuzzaman, 2021b). 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 m<sup>3</sup> of tank was 201.56 g and 248.08 g in T<sub>1</sub> and T<sub>2</sub>, respectively. Converting the total production per decimal production, the total production is become 8.06

kg/decimal and 9.92 kg/decimal in T<sub>1</sub> and T<sub>2</sub>, respectively for 100 days culture period. The production was higher in T<sub>2</sub> than T<sub>1</sub>. There was no significant difference ( $p > 0.05$ ) in term of total production of rohu between two treatments. The mean values of water temperature in T<sub>1</sub> and T<sub>2</sub>  $27.48 \pm 0.397^\circ\text{C}$  and  $27.49 \pm 0.392^\circ\text{C}$ , respectively. The suitable range of rohu culture temperature is  $27.30^\circ\text{C}$  to  $33.50^\circ\text{C}$  (Alim, 2005). Shaha *et al.* (2015) recorded temperature range of  $22.6^\circ\text{C}$  to  $32.5^\circ\text{C}$  suitable for fish culture which is very similar to the present study. The water temperature of the experimental tanks was within the suitable range of rohu culture. The mean values of dissolved oxygen of water of the experimental tanks were  $6.46 \pm 0.159$  and  $6.48 \pm 0.130$  in T<sub>1</sub> and T<sub>2</sub>, respectively. Higher level of dissolved oxygen concentration was recorded in the experimental tanks as a result of using blower for aeration. According to Rahman (1992), DO content of productive pond should be 5 ppm or more. Narejo *et al.* (2010) reported that the range of DO content of water from 4.70 to 6.80 mg/l was within the good productive range. From the above findings, it can be concluded that dissolved oxygen concentration in the study was suitable for rohu culture in tanks. The mean values of pH were found as  $8.39 \pm 0.177$  and  $8.39 \pm 0.175$  in T<sub>1</sub> and T<sub>2</sub>, respectively. The pH found in the present study was suitable for rohu culture.

## CONCLUSION

Aquaculture production largely depends on required amount of feed in different growth stages. It reduces the feed cost and at the same time reduces the wastages and comparatively a little chance of water quality deterioration. By knowing specific growth rate (SGR), the proper amount of feed needed for the fish in different stages of growth can be calculated. This study suggests that tank-based aquaculture can be developed in the indoor system with ensuring 100% survival and has proven the possibility of intensive culture of rohu by using commercial floating feed. This experiment revealed the efficacy of commercial floating feed in terms of intensive culture of rohu that imparted an outstanding growth performance and suggests to practice at farmers level to get more financial gain from a limited area.



**CONFLICT OF INTEREST**

There is no conflict of interest.

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