ASSESSMENT OF GROWTH PERFORMANCE, FEED UTILIZATION AND SURVIVAL OF KURSHA, *LABEO DERO* FRY IN AQUARIUM WITH DIFFERENT STOCKING DENSITY

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KEYWORDS: aquarium, growth, *Labeo dero*, nursery stage, stocking density.

ABSTRACT

Approximately, 0.36 ± 0.10 g weight of kursha, *Labeo dero* (Hamilton, 1822) fry were stocked in aquaria and fed with commercial feed for 45 days to evaluate the effect of different stocking densities on growth performance, feed utilization, and survival. Three different treatment with the stocking density was maintained at 1 fry L^{-1} (T_1), 1.5 fry L^{-1} (T_2) and 2 fry L^{-1} (T_3) respectively with having three replicates. The survival rate of all treatments was found to be above 90%. After 45 days of rearing period, growth performances (mean weight gain, SGR) and feed utilization parameters (FCR, PER) was found significantly ($p < 0.05$) better in T_2 followed by T_1 and T_3.

RÉSUMÉ: Évaluation des performances de croissance, de l'utilisation des aliments et de la survies des alevins de Kursha, *Labeo dero* (Hamilton, 1822) dans un aquarium avec différentes densités de peuplement.

Environ 0,36 ± 0,10 g de poids d'alevins de kursha, *Labeo dero* (Hamilton, 1822) ont été stockés dans des aquariums et nourris avec des aliments commerciaux pendant 45 jours pour évaluer l'effet de différentes densités de stockage sur les performances de croissance, l'utilisation des aliments et la survie. Trois traitements différents avec la densité de stockage ont été maintenus à 1 alevin L^{-1} (T_1), 1,5 alevin L^{-1} (T_2) et 2 alevins L^{-1} (T_3) respectivement avec trois répétitions. Le taux de survie de tous les traitements s'est avéré supérieur à 90%. Après 45 jours d'élevage, les performances de croissance (gain de poids moyen, SGR) et les paramètres d'utilisation des aliments (FCR, PER) se sont avérés significativement ($p < 0,05$) meilleurs dans le traitement T_2 suivi de T_1 et T_3.

REZUMAT: Evaluarea performanței de creștere, a utilizării furajelor și a supraviețuirii puilor de Kursha, *Labeo dero* (Hamilton, 1822) în acvarii cu densități diferite de populare.

Aproximativ 0,36 ± 0,10 g greutate de pui de kursha, *Labeo dero* (Hamilton, 1822) au fost stocați în acvarii și hrăniți cu furaje comerciale timp de 45 de zile pentru a evalua efectul diferitelor densități de stocare asupra performanței de creștere, a utilizării hranei și a supraviețuirii. Trei tratamente cu densitatea de stocare diferite au fost menținute la 1 alevin L^{-1} (T_1), 1,5 alevini L^{-1} (T_2) și, respectiv, 2 alevini L^{-1} (T_3), având trei replici. Rata de supraviețuire a tuturor tratamentelor s-a dovedit a fi peste 90%. După 45 de zile de perioadă de creștere, performanța de creștere (creștere medie în greutate, SGR) și parametrii de utilizare a furajului (FCR, PER) s-au găsit semnificativ ($p < 0,05$) mai bune în tratamentul T_2 urmat de T_1 și T_3.

INTRODUCTION

Stocking density is considered as a crucial metric for assessing the financial sustainability of aquaculture unit (Keer et al., 2018). Aquaculture requires ideal stocking density all over the species' life span to avoid stress on fish and possible commercial loss. Lower stocking densities without considering the optimization of space can increase production costs and reduce profits in aqua farm (Barton, 2002). The fry or larval stage is considered the most sensitive stage in the life cycle of most of the fish species as high mortality occurs at this stage. Stocking density and management measures practiced by pond operators in Bangladesh are not based on scientific knowledge, resulting in poor growth and survival of fry. High stocking density of one species can affect the growth of other species; conversely, low stocking density of a species can reduce the overall production (Apu et al., 2012; Rahman and Marimuthu, 2010). Thus ponds need to be stocked at the correct stocking density for optimal growth to obtain maximum economic returns (Mollah et al., 2011).

Among 260 freshwater species, Kursha, *Labeo dero* (Hamilton, 1822) is known as "kursha", "khursha" or "katal khushi" belongs to the family cyprinidae of the order Cypriniformes. It is also known as "Kalabans" in India, "Gardi" and "Kathalegi" in Nepal, and "Kursa" in Bangladesh. The maximum length of this fish species is 16.6 cm (Rahman, 1989, 2005) and 75 cm (Talwar and Jhingran, 1991). The fish is typically white in color, with a longer body and a smaller head (Kumar and Yadav, 2021). Its typical habitats are the shallow water streams in the upland rivers of Bangladesh's Dinajpur, Rangpur and Mymensingh districts (Rahman, 2005, 1989; Talwar and Jhingran, 1991). This benthopelagic fish is herbivore and mainly feeds on aquatic debris and detritus (Raina and Petr, 1999). In the Rangpur area, it is regarded as flavorful dish that is high in nutrients and good for human health. Additionally, this species is frequently utilized as bait for other fish that are significant to the economy, like *Tor putitora* (Hamilton, 1822) and *Raiamas bola* (Hamilton, 1822) (Talwar and Jhingran, 1991).

Apart from the northern towns of the country, this fish was prevalent in the Mymensingh region. Due to some factors, such as pollution of water bodies, use of current net in rivers, unplanned development projects for irrigation and flood control, changes in river flow and human activity, the abundance of this fish is currently very rare (Rahman, 2005) and regarded as vulnerable (Mahanta et al., 1994). The International Union for Conservation of Nature (IUCN) (2015) therefore enlisted *L. dero* as Data Deficient (DD). Thus, the development of a suitable technology for rearing of fry and fingerlings in nursery stages is essential to maintain both the fish population and its population dynamics. Bangladesh Fisheries Research Institute (BFRI) (2022) has already developed artificial breeding techniques and farming practices of 31 endangered fish species, including *L. dero*, to protect the fish species and boost their availability and productivity.

Screening of literature shows that there no systematic research has been done on the stocking density of *L. dero* rearing during the nursery phase in Bangladesh. In order to properly farm this fish and get the highest potential production, it is required to determine the optimum stocking density.

Considering the above facts, this research experiment was conducted to evaluate the effects of stocking density on the growth performances of *L. dero* in aquarium at nursery stages where the main goal was to protect this fish from extinction and to conserve its natural stocks.

MATERIAL AND METHODS

Experimental site

This research was carried out in nine glass aquaria (95 cm × 40 cm × 52 cm) at the hatchery complex of BFRI, Freshwater Sub-station, Saidpur, Nilphamari, in Rangpur division over a 45 days (10 October to 23 November 2024) period (Fig. 1).

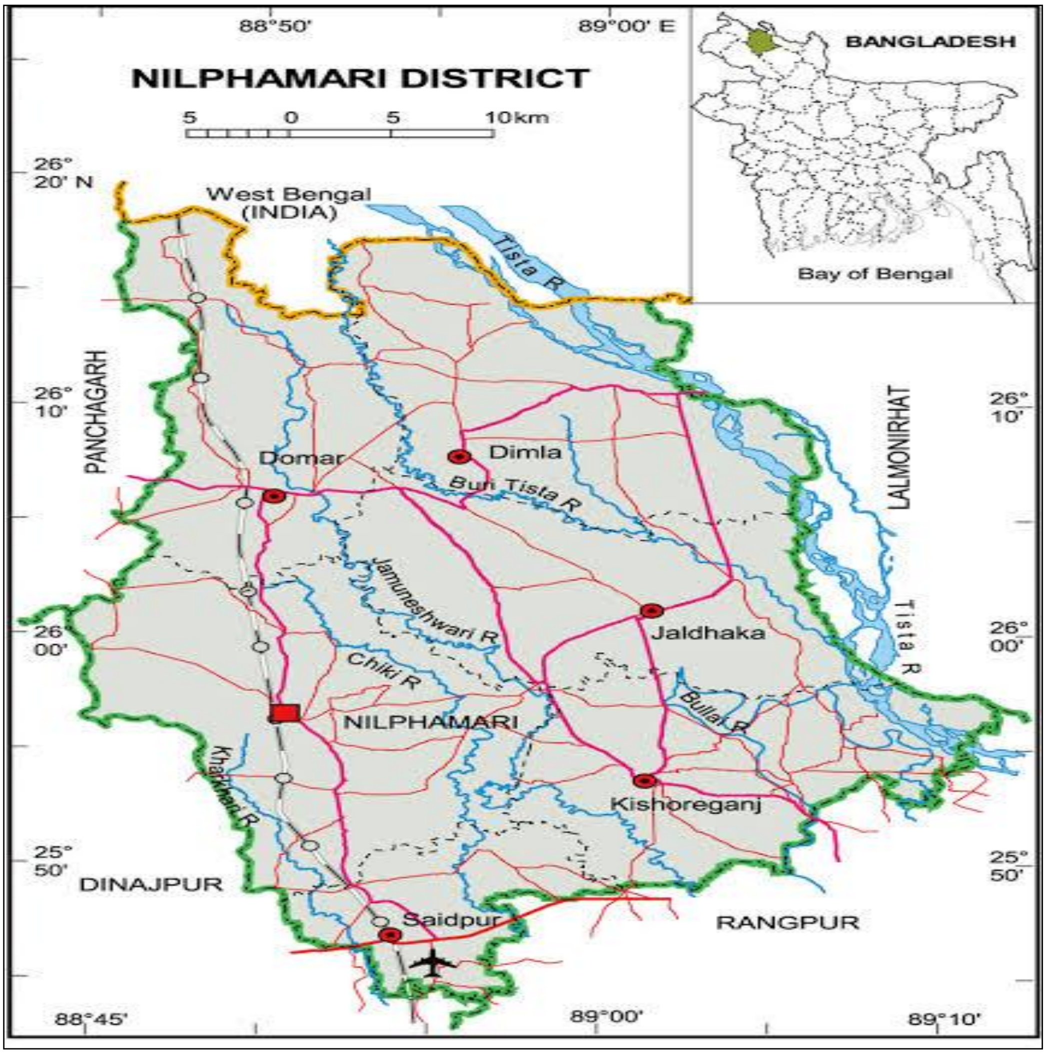

Figure 1: Map presenting the study area of Saidpur area in Nilphamari District.

Experimental design

Before the trial started, *L. dero* fry were collected from the nursery pond of the BFRI freshwater sub-station, Saidpur and acclimatized for about one hour. After that, fry (mean length 3.2 ± 0.62 cm and mean weight 0.36 ± 0.10 g) were stocked randomly in all glass aquaria having a 30 L water capacity and an aerator, at three different stocking density, 1 fry L^{-1}, 1.5 fry L^{-1} and 2 fry L^{-1} of water. Thus the stocking density was 30, 45, 60 fry per aquarium which represented as T_1, T_2 and T_3 respectively with three replications each (Tab. 1).

Table 1: Culture of Kursha under different stocking densities in aquarium.

Treatments	Replication	Stocking density (ind. L^{-1})	No. of fry (per aquarium)
T_1	R_1	1	30
	R_2		
	R_3		
T_2	R_1	1.5	45
	R_2		
	R_3		
T_3	R_1	2	60
	R_2		
	R_3		

Aquarium preparation and maintenance

For the preparation of nine aquaria, glass sheets were first cut to the desired size (95 cm × 40 cm × 52 cm), sealed with silicon gum and allowed to air dry for a minimum of 48 hours. Following that, a light salt solution was used to clean the aquarium and all the dirt was siphoned out. Next, clean water was added to the aquarium. Throughout the experiment, an electric pump was used to supply water from underground. A stone aerator was installed at the bottom of each aquarium to regulate the oxygen level. In order to keep the fish from escaping an aquarium hood made up of glass sheet was also incorporated. Eventually, the aquaria were fixed in the flat, sturdy metal platform that could support the weight of the complete set. The entire aquarium structure was installed in a location with the most light available.

Feed and feeding

For the period of 45 days fish were fed with a commercial powdered feed four times a day with four equal portions (6:00, 12:00, 18:00, and 24:00) at the rate of 30% body weight for the first 15 days, 20% for the second 15 days and finally 15% for the last 15 days. After 30 minute of feed administration, the residual feed particles were periodically siphoned out and tanks were cleaned routinely to lessen up the nitrogenous buildup.

Water quality assessment

The water quality parameters of each aquarium like temperature, pH, dissolved oxygen and total dissolved solids were recorded on daily basis by using a HI98494 pH/EC/DO Multiparameter. Approximately, 30% of water replacement was done and clean water was added to the aquarium to re-adjust the water level.

Collection of sample

For the evaluation of fish growth performances, sampling was done in seven days intervals. The stocked fish were observed for mortality, food consumption and behavior on a daily basis. A sample size of 10 fish from each aquarium was collected randomly by using a scoop net to observe the growth parameters i.e. body weight and total length. Sampling was done very carefully to avoid the handling stress and mechanical injury. After taking the data fish were released back to their respective aquaria. The length (cm) and weight (g) of individual fish was recorded separately by using a measuring scale and a digital balance (EK 600i) to adjust the amount of feed (Figs. 2a, b). After 45 days of rearing period fries were completely harvested by using a scoop net and the number of individuals were counted to determine their survival rate.

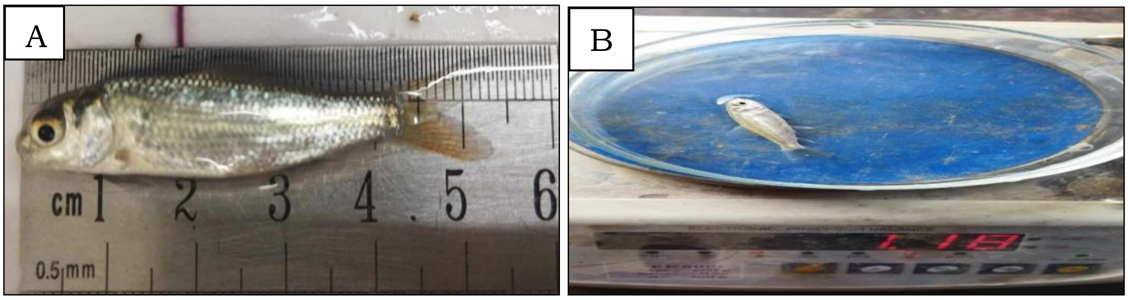

Figure 2: (A) Measurement of length (cm) and (B) weight (g) of *L. dero*
during the study period
by using a measuring scale and electronic balance.

Determination of growth, feed utilization and survival

Final weight, weight gain, percent weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio and survival rate were calculated at the end of the rearing period by using the following formulae:

a) Weight gain

Weight gain (g) = Final weight (g) – Initial weight (g)

b) % Weight gain

Percent weight gain (%) = Final weight (g) – Initial weight (g)/ Initial weight (g) x 100

a) Specific Growth Rate (SGR % day^{-1})

$$SGR\ (\%\ day^{-1}) = \ln W_2 - W_1/T_2 - T_1 \times 100$$

Where,

W_1 = the initial live body weight gain (g) at time T_1 (day)

W_2 = the final live body weight gain (g) at time T_2 (day)

b) Feed Conversion Ratio (FCR)

FCR = Total dry feed intake (g)/Total wet weight gain (g)

c) Protein Efficiency Ratio (PER)

PER = Live weight gain (g)/Crude protein fed (g)

d) Survival rate (%)

c) Survival rate (%) = Final number of fish/Initial number of fish x 100

Data analysis

All data were tested using one-way analysis of variance (ANOVA). Significant ($p < 0.05$) results were further tested using one-way ANOVA followed by Duncan's Multiple Range Test (DMRT) to identify significant differences between means. The data were expressed as mean ± SD and statistical analysis was performed using Statistical Package for Social Sciences, SPSS 25 (Chicago, USA) and Microsoft Office Excel for Window.

RESULTS AND DISCUSSION

Water quality parameters

Water quality parameters such as temperature, pH, DO and TDS were measured regularly and ranged between 20.38-24°C, 7.44-8.65, 7.03-8.69 ppm and 107-118 ppm, respectively and did not differ significantly ($p > 0.05$) among the three treatments (Tab. 2).

Table 2: Mean ± SD of water quality parameters of the experimental aquariums.

Parameters	Treatments		
	T_1	T_2	T_3
Temperature (°C)	22.69 ± 0.96	22.13 ± 1.03	22.54 ± 0.92
	(20.59-24)	(20.38-23.22)	(20.82-23.74)
Water pH	8.02 ± 0.24	8.03 ± 0.22	8.16 ± 0.33
	(7.45-8.19)	(7.97-8.65)	(7.44-8.47)
DO (ppm)	7.88 ± 0.61	8.26 ± 0.22	8.23 ± 0.21
	(7.03-8.68)	(7.97-8.65)	(7.98-8.69)
TDS (ppm)	112.56 ± 2.87	111.44 ± 2.77	114 ± 2.61
	107-116	108-116	110-118

Fish growth performance, feed utilization parameters and survival

Fish growth performances, feed utilization and survival of *L. dero* fry in aquarium under different stocking densities were recorded weekly during nursing period are given in table 3 and figures 3-6. Generally, growth parameters such as weight gain (2.70 ± 0.02), percent weight gain (745.30 ± 12.66), SGR (4.74 ± 0.03), feed utilization parameters such as FCR (2.07 ± 0.03), PER (1.73 ± 0.02) were density dependent and significantly improved ($p < 0.05$) in treatment 2 (1.5 fry.L^{-1}) compared to the other treatments. The survival rate of *L. dero* fry did not differ significantly ($p > 0.05$) among the treatments and found above 90% in all the three treatments.

Table 3: Growth performances, feed utilization and survival of kursha, *L. dero* (Hamilton, 1822) fry in different treatments over 45 days of nursing period in aquarium; Data presented as mean ± SD; obtained from three replicate aquaria, n = 3; Data with different superscripts in the same row indicate significant differences ($p < 0.05$); wt. = weight; ADG = Average Daily Gain; SGR = Specific Growth Rate; FCR = Food Conversion Ratio; PER = Protein Efficiency Ratio; FI = Feed Intake.

Parameters	Treatments		
	T_1	T_2	T_3
Initial mean weight (g)	0.36 ± 0.1	0.36 ± 0.1	0.36 ± 0.1
Final mean weight (g)	2.54 ± 0.03^{ab}	3.06 ± 0.04^{a}	2.21 ± 0.11^{b}
Initial length (cm)	3.2 ± 0.62	3.2 ± 0.62	3.2 ± 0.62
Final length (cm)	5.5 ± 0.19^{ab}	6.04 ± 0.28^{a}	5.4 ± 0.39^{b}
Mean weight gain (g)	2.18 ± 0.02^{ab}	2.70 ± 0.02^{a}	1.58 ± 0.01^{b}
Percent weight gain (%)	602.58 ± 4.22^{b}	745.30 ± 12.66^{a}	468.51 ± 58.50^{c}
Average daily gain (day^{-1})	4.84 ± 0.03^{b}	6.00 ± 0.10^{a}	3.51 ± 0.02^{c}
SGR (% day^{-1})	4.33 ± 0.01^{b}	4.74 ± 0.03^{a}	4.02 ± 0.02^{c}
FCR	2.14 ± 0.02^{ab}	2.07 ± 0.03^{b}	2.22 ± 0.03^{a}
PER (%)	1.67 ± 0.02^{ab}	1.73 ± 0.02^{a}	1.61 ± 0.02^{b}
Feed intake (g/individual)	4.48 ± 0.15^{ab}	5.48 ± 0.17^{a}	3.89 ± 0.22^{b}
Survival rate (%)	95.56 ± 1.57	94.07 ± 3.78	94.44 ± 3.14

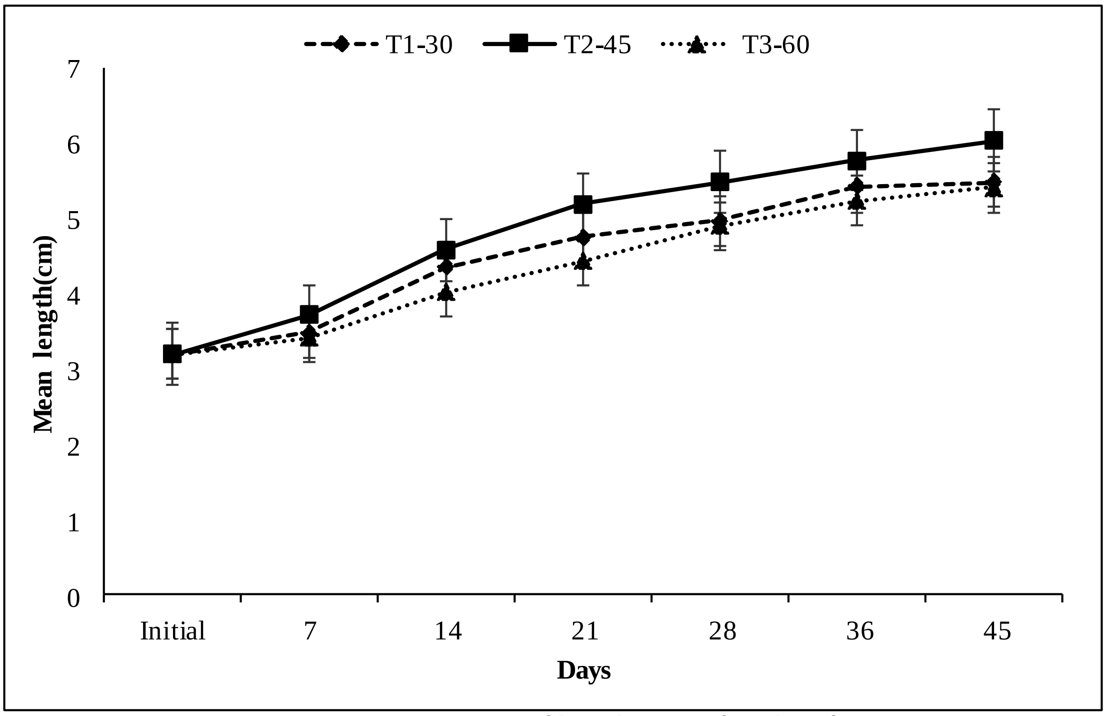

Figure 3: Improvement of length (cm) of *L. dero* fry
at different stocking densities over the nursing periods of 45 days.

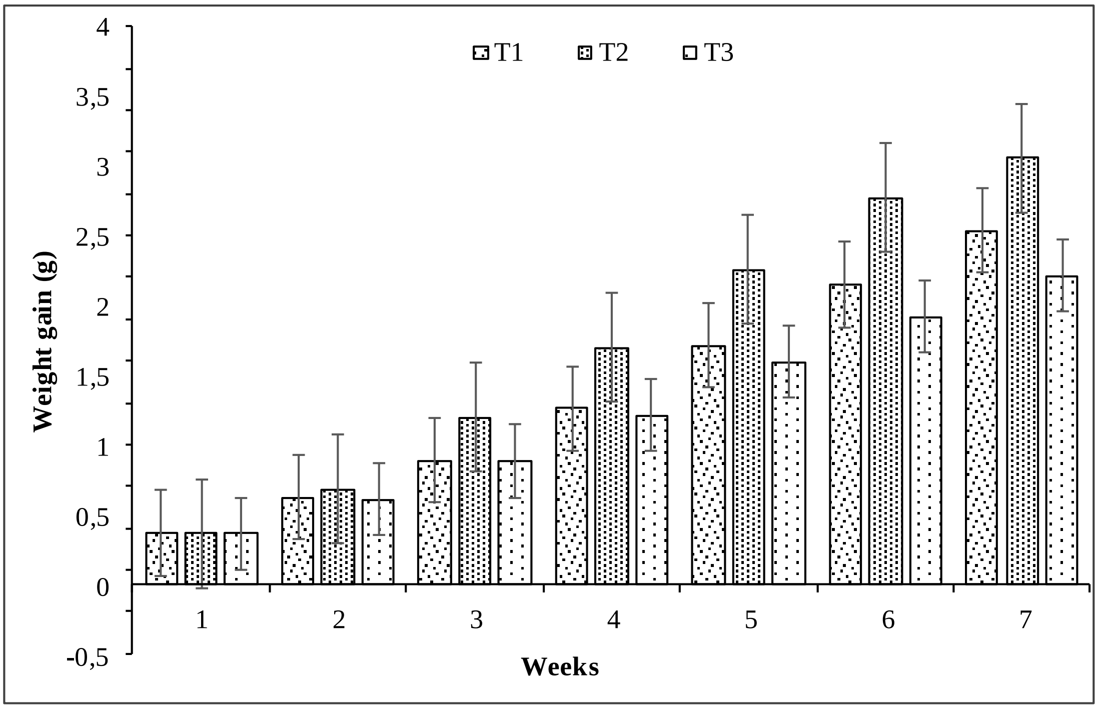

Figure 4: Weight gain (g) of *L. dero* fry
in different treatments during the rearing period.

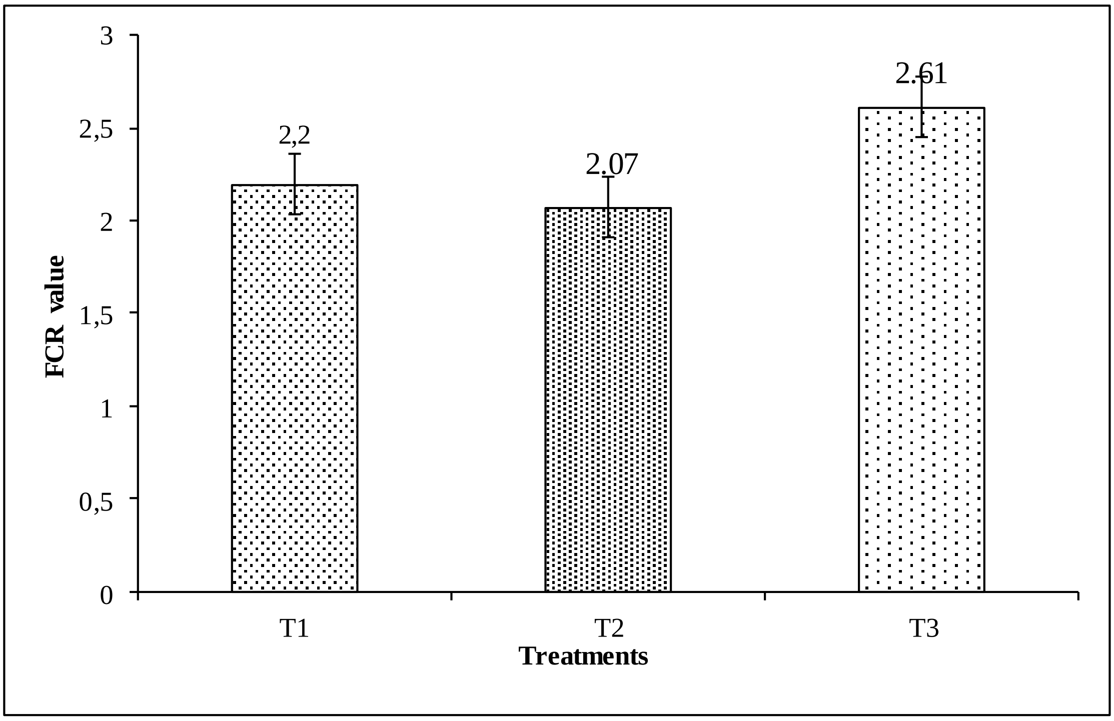

Figure 5: FCR value of *L. dero* fry
at the end of the study period.

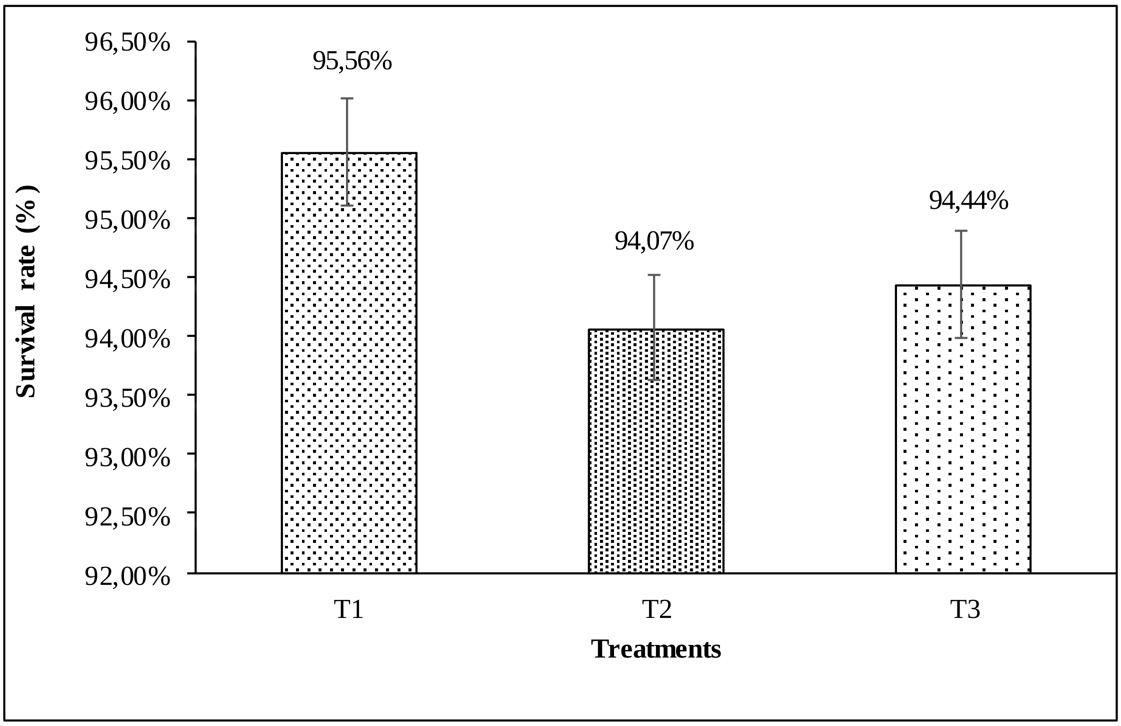

Figure 6: Survival rate of *L. dero* fry
at the end of the study period.

Environmental parameters greatly influence the maintenance of healthy aquatic environment and the production of food organisms in aquaculture. Fish culturists are more aware of maintaining optimal water quality conditions. However, fish growth, feed efficiency, and feed utilization are generally controlled by a few environmental factors (Brett, 1979; Fry, 1971).

In the present study, the water temperature, pH, DO, and TDS ranges from 20.38-24°C, 7.44-8.65, 7.03-8.69 ppm and 107-118 ppm, respectively. The results of this research revealed that all the values did not differ significantly among the treatments and fell within the ideal range for primary nursing of *L. dero* fry as stated by Boyd (1982) which suggested that the fish were not subjected to any environmental stress. Similar findings of temperature, pH, DO also reported by Chakraborty and Mirza (2007) in endangered *Labeo bata* fry, Priyadarshini et al. (2011) in *Cyprinus carpio* fry, Nath et al. (2014) in *Clarias batrachus* fry, Hossain (2014) in *Hypopthalmichthys molitrix*, *Cyprinus carpio specularis* and *Labeo rohita* fry nursing. In the present study, the mean value of TDS was recorded as 112.56 ± 2.87, 111.44 ± 2.77 and 114 ± 2.61 ppm in T_1, T_2 and T_3 respectively.

After 45 days of nursing, the results of this research revealed that growth performance in terms of final weight gain, percent weight gain, average daily weight gain, SGR, differed in various stocking densities, with T_2 had a significantly ($p < 0.05$) higher growth rate followed by T_1 and T_3. No previous studies were conducted in Bangladesh on the growth rate of *L. dero* at various stocking density specially at the nursing stage.

In the present research, the recorded maximum weight gain was observed in T_2 (3.06 ± 0.04) where stocking density was 1.5 fry L^{-1} and the minimum in T_3 (2.21 ± 0.11) where stocking density was 2 fry L^{-1}. Although all the experimental fish were fed with the same diet at an equal ration. This might be due to the lower stocking density resulting in more space, food and less competition, and a lower sense of community among the fish which influences them to consume food properly which is relevant with the findings of (Keer et al., 2018; Jena et al., 1998). On the contrary, in T_3 fish got limited area which affected the community and increased stressed condition. As a result, fish expend more energy to relieve the stress which hindered their ability to develop soundly which coincides with the study of Scherek (1982) who observed that stressed animal expend more energy on maintaining homeostatic which subsequently causes growth depression.

During the investigations of this research, the maximum value of percent weight gain was found in T_2 (745.30 ± 12.66) whereas the lowermost was found in T_3 (468.51 ± 58.50). This might be because the use of the intensive system for rearing. Percent weight gain was found better (15 fingerlings/tank) during farming of *Oreochromis nilotica* fingerlings in semi closed culture system (Salih et al., 2016); *Tor soro* fingerlings (4 ind. L^{-1}) in recirculatory aquaculture system (RAS) (Haser et al., 2022). In line with this research, Narejo et al. (2010) showed that maximum percent weight gain was observed when *Labeo rohita* reared in aquarium (1.5 fry L^{-1}) condition.

FCR and PER is a dietary intake indicator which is used to narrate the rate of growth and feed utilization ability of farmed fish (Amin et al., 2005). Treatment 2 (1.5 fry.L^{-1}) showed the most efficient FCR (2.07 ± 0.03) and PER (1.73 ± 0.02) value compared to the rest of the treatments. This could be because fish in T_2 utilized the feed most efficiently in less crowding environment because of the smaller ration size, a higher digestibility which is relevant with the findings of Mou et al. (2018) who reported improved FCR value at the lower stocking density during the nursing of *Mystus vittatus* (Bloch, 1794) fry. On the other hand, T_3 exhibited the inefficient FCR (2.22 ± 0.03) and PER (1.61 ± 0.02) value that might be the outcome of a stressful environment caused by a higher stocking density, which in return increased competition for food and space and became fish less efficient to utilize the feed. Fish usually exhibits dominating behavior during food consumption (Ruzzante, 1994; Magnuson, 1962). Previous studies have shown that both low and high stocking density than optimum can induce stress in fish (Barlaya et al., 2021; Alanara and Brannas, 1996; Jorgensen et al., 1993; Brown et al., 1992). Therefore optimum stocking density must be evaluated for individual fish species.

The survival rate of *L. dero* was 95.56%, 94.07% and 94.44% in treatments $T_{1,}$ T_2 and T_3 respectively. However, the stocking density did not affect the survival rate of *L. dero*. A non-significant ($p > 0.05$) higher survival was noted when *L. dero* was stocked at 1 fry.L^{-1} (T_1). This might be because the seeds were very hardy and the favorable environmental conditions in the aquarium allowed the *L. dero* species to survive better which coincides with Paswan et al. (2021) who stated that *L. rohita* (Hamilton, 1822) fry showed better survival rate in stressed condition because the seeds were hardy. Also researchers found that favorable environmental condition play a great role in the survival of fish in captivity (El-Sherif and El-Feky, 2009). In line with this research, Arifin et al. (2017) showed stocking density had no indicatory or direct effect on *Barbonymus balleroides* (Valenciennes, 1842) survival. Similarly, Kunda et al. (2021) indicated that survivability of *Oreochromis nilotica* did not vary significantly along with stocking density. On the contrary, Narejo et al. (2010) observed survival rate of *L. rohita* significantly ($p < 0.05$) differed in different stocking density when reared in aquarium.

CONCLUSIONS

Finally, it can be concluded that the growth, feed utilization parameters and survival of *L. dero* fry showed an increasing trend up to T_2, thereafter it showed a decreasing trend. In all aspects, T_2 (1.5 fry L^{-1}) showed highest values compared to the other treatments. Thus, stocking density 1.5 fry L^{-1} may be advisable for rearing of *L. dero* fry for 45 days of nursing period. The spawning and feeding ground of this important fish species have suffered significant degradation due to human involvement and environmental changes. Under these circumstances, the application of this current findings to the production of sufficient quality seeds may prove to be beneficial in preventing the extinction of *L. dero* and in promoting its conservation and rehabilitation. However, further research on standardization of stocking density along with economic profitability of this fish can be conducted to add more insight to this research work.

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