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EFFECT OF STOCKING DENSITY ON SURVIVAL, GROWTH AND PRODUCTION OF INDIGENOUS *LABEO CALBASU* (HAMILTON, 1822) IN NURSERY PONDS

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Abstract: : Effect of stocking densities on the growth, survival and production of kalibaus, *Labeo calbasu* fry and fingerlings were tested in a single-stage nursery rearing system. The experiment was conducted for a rearing period of six weeks in nine earthen nursery ponds having an area of 0.028 ha each. Four-day-old hatchlings stocked at 0.6 million/ha were designated as treatment T_1, 0.8 million/ha as treatment T_2 and 1.0 million/ha as treatment T_3. At stocking, all hatchlings were of the same age with a mean length and weight of 6.50±0.01cm and weight of 0.007±0.00g, respectively. Physico-chemical parameters and plankton populations were at the optimum level for the culture period. Highest weight gain was observed in treatment T_1 and lowest in treatment T_3. Final length, final weight and survival of fingerlings also followed the same trends as weight gain. Fingerlings in treatment T_1 produced significantly higher specific growth rate than treatment T_2 and T_3. Feed conversion ratio was significantly higher in treatment T_1 followed by T_2 and T_3. Significantly higher number of fingerlings was produced in treatment T_3 than in T_2 and T_3. Overall, highest growth, survival and net benefits of fingerlings were obtained in the treatment T_1 at a density of 0.6 million hatchlings/ha. Therefore, of the three stocking densities, 0.6 million hatchling/ha appears to be the most suitable stocking density for nursing and rearing of *L. calbasu* fry and fingerlings.

Keywords: Fingerlings, Fry, Growth, Hatchling, *Labeo calbasu*, Production, Stocking density.

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INTRODUCTION

Labeo calbasu is vernacularly known as Calbasu/ Kurcha/ Mahlee/ Kalabeinse in India; Kalibaus/ Kalbasu in Bangladesh; Nga-nek-pya/ Nga-noo-than/ Nga-ong-tong/ Nga-gyeen-boo in Myanmar (Chondar, 1999). *L. calbasu* is the most important carp species next to the three Indian major carps *i.e. Labeo rohita, Catla catla* and *Cirrhinus mrigala* (Chondar, 1999). It is a freshwater fish species belonging to the family Cyprinidae under the order Cypriniformes. It is a popular food fish having good taste, less intramuscular bones and high protein content; also admired as a good sport fish (Talwar and Jhingran, 1991; Rahman, 2005). This fish species supports an important commercial fishery in rivers and reservoirs of different countries mainly in the Indian sub-continent (Pathak and Jhingran, 1977; Dwivedi *et al.,* 2004; Nautiyal *et al.,* 2004; Chakraborty *et al.,* 2021a; Arifuzzaman *et al.,* 2022).

Recently the entry of the fish as an ornamental fish markets of India (Gupta *et al.,* 2012) and also has been reported to be exported as indigenous ornamental fish (Gupta and Banerjee, 2014). The natural populations of fish species in general has seriously declined due to overfishing, habitat degradation, aquatic pollution, dam construction and several other anthropological reasons, which are affecting its feeding migration and spawning (CAMP, 1998; Chakraborty, 2021; Chakraborty *et al.,* 2021b; Chakraborty and Mome, 2022).

In Bangladesh, it has been documented as endangered species according to the red list of IUCN Bangladesh, 2000. Recent studies suggest that worldwide 20% of all freshwater species are extinct, endangered or vulnerable (Moyle and Leidy, 1992). So, it is essential to save this fish from extinction through development of appropriate nursing and rearing techniques of fry and fingerlings of *L. calbasu*. This technology will prevent the fish from being extinct and at the same time rural people will have the opportunity to catch and eat this delicious fish if open water bodies are stocked with fingerlings.

Availability of *Labeo calbasu* (Hamilton, 1822) in indigenous water, culture suitability with other carp species, great market demand and high nutritional quality makes it a good table fish (Ali *et al.,* 2014; Halder *et al.,* 2020). This fish has enormous aquaculture potential and it could be easily grown in fish ponds along with other polyculture species. In order to do so, a huge quantity of fingerling would be required. Therefore, acceptable and suitable culture methods for nursing and rearing of *L. calbasu* larvae are very important to ensure reliable and regular supply of fingerlings. Improper care and lack of understanding about the biotic and abiotic factors in the rearing system may result in mass mortality of young fry (Jhingran and Pullin, 1985). Success in fry nursing depends on a good knowledge of nutritional and environmental requirements of the larvae in the open aquatic ecosystem (Mollah, 1985).

However, electronic wastes, anthropogenic activities, microplastics etc. badly affect the biodiversity and ecosystem (Ashok, 2017 and 2018; Verma and Praksh, 2020 and 2022; Prakash and Verma, 2022). Therefore, the present experiment was conducted to develop a practical and economically viable methodology for large scale production of fry and fingerlings in order to enhance the food security.

MATERIALS AND METHODS

1. Study area and experimental design

The research was carried out at the private nursery ponds of Al-Amin Fish Seed Farm, Ishorgonj, Mymensingh, Bangladesh. The experiment was conducted for a period of 6 weeks from July to August, 2022 in nine earthen nursery ponds with a surface area of 0.011ha with an average depth of 0.9 meter. The ponds were having similar rectangular size, depth, basin conformation, contour and bottom type. Three treatments differing in stocking densities of hatchlings were tested with three replicates each. Stocking densities were 0.60 million/ha (treatment T_1), 0.8 million/ha (treatment T_2) and 1.0 million/ha (treatment T_3).

2. Pond preparation

The ponds were dewatered, freed from aquatic vegetation, exposed to full sunlight and had a well-designed system of inlet and outlet. After drying, quicklime ($CaCO_3$, 250 kg/ha) was spread over the pond bottom. All the ponds were filled with groundwater. Five days subsequent to liming, the ponds were fertilized with organic manure (cow dung @ 2470 kg /ha). Seven days after manuring the pond water was sprayed with dipterex (1.0 ppm) to eradicate harmful insects and predatory zooplankton. The experimental ponds were stocked with 4 days old *L. calbasu* having an initial length of 6.50±0.01cm and weight of 0.007±0.00g, respectively.

3. Fertilization

After stocking fry, all the ponds were fertilized with cow dung at the rate of 250 kg/ha, urea 25.0 kg/ha and TSP 12.5 kg/ha at weekly intervals to stimulate the primary productivity of the ponds throughout the experimental period.

4. Supplementary feeding

In order to meet the increasing dietary demand, supplementary feed consisting of a mixture of mustard oilcake, rice bran, wheat bran, and fish meal in 40:25:25:10 proportions was supplied at the rate of 10-12% of their total biomass twice daily commencing from the first day of stocking. The rate of feeding was 20 kg/million hatchlings per day for the first one week, 24 kg for the second week, 28 kg for the third 2 weeks and 32 kg for the fourth two weeks. Proximate composition of the feeds was analyzed according to AOAC (1984) method, nitrogen free extract (NFE) by subtraction (Castell and Tiews, 1980). Proximate composition (% dry matter) of the supplementary feeds (crude protein, crude lipid, Crude fiber, ash and nitrogen-free extract) of experimental feeds was 32.80%, 7.84%, 11.15%, 17.84% and 30.37%, respectively.

5. Water Quality Parameters

Physico-chemical parameters of pond water were monitored weekly between 9.00 and 10.00 h. Water temperature was recorded using a Celsius thermometer and transparency (Clesceri *et al.*, 1989).

6. Plankton monitoring

Quantitative and qualitative estimates of plankton in the nursery ponds were taken weekly. Water from different locations and depths of each pond were collected and (cm) was measured by using a Secchi disc of 20 cm diameter. Dissolved oxygen and pH were measured directly using a digital electronic oxygen meter (YSI, Model 58, USA) and an electronic pH meter (Jenway, Model 3020, UK). Total alkalinity was determined by titrimetric method (filtered through fine-meshed plankton net (0.04 mm) to obtain a 50 ml sample. The samples were preserved immediately with 5% buffered formalin in plastic bottles. Plankton density was estimated by using a sub-sampling technique. A Sedgwick-Rafter (S-R) cell was used under a calibrated compound microscope for plankton counting. Plankton count (number of cells per liter of water sample) was made using the formula proposed by Stirling (1985) and Rahman (1992).

7. Estimation of growth, survival, production and feed utilization

Twenty five individuals from each pond were sampled weekly until they attained the fingerlings stage. Growth in terms of length and weight, average daily gain (ADG), specific growth rate (SGR) and food conversion rate (FCR) was estimated. The ADG, SGR and FCR were calculated according to Brown (1957), Castell and Tiews (1980) and Gangadhara *et al.* (1997) respectively. After six weeks, the fingerlings were harvested by repeated netting, followed by drying the ponds. The fingerlings were counted and weighed.

Fry and fingerlings were sampled weekly to record their length and weight (g). The growth rate was estimated by using the following formula:

$$\text{Growth (\%)} = \frac{W_2 - W_1}{W_1} \times 100$$

Where, W_2 = Final weight of fish
W_1 = Initial weight of fish

$$\text{Average daily gain (ADG)} = \frac{Mf - Mi}{T_2 - T_1}$$

Where, $T_2 - T_1$ = culture period (in days)
Mf = Mean final weight
Mi = Mean initial fish weight

$$\text{Specific Growth Rate (SGR \%)} = \frac{LnW_2 - LnW_1}{T_2 - T_1} \times 100$$

(Brown, 1957)

Where,
LnW_2 = natural log of mean final weight of fish at time T_2
LnW_1 = natural log of mean final weight of fish at time T_1
$T_2 - T_1$ = culture period in days

$$\text{The food conversion rate (FCR)} = \frac{Ts}{Tb}$$

(Gangadhara *et al.*, 1997)

Where, Ts = Total supplementary feed given (kg)
Tb = Total body weight gain (kg)

After 42 days of rearing, fishes were harvested from all the ponds by using seine net.

$$\text{Survival rate (SR \%)} = \frac{\text{No. of fish harvested}}{\text{Initial no. of fishes}} \times 100$$

8. Analysis of experimental data

The data were analyzed through one way analysis of variance (ANOVA) using MSTAT followed by Duncan's New Multiple Range test to find out whether any significant difference existed among treatment means (Duncan, 1955; Zar, 1984). Standard deviation in each parameter and treatment was calculated and expressed as mean ±S.D. A simple cost-benefit analysis was done to estimate the net benefits from different treatments.

RESULTS AND DISCUSSION

1. Water quality parameters

Mean levels of physico-chemical parameters over the seven week nursing of fry and fingerlings are presented in Table 1. The mean water temperatures in treatment T_1, T_2 and T_3 were not statistically significant (*P*>0.05). Mean secchi disk transparency differed significantly (P<0.05), increasing from T_1 to T_3. Dissolved oxygen content was relatively lower in treatment T_3 (4.81±0.61 mg/l) in the morning as compared to the treatment T_1 and T_2 (5.02±0.39 and 4.84±0.50 mg/l), respectively. The mean dissolved oxygen (DO) obtained in the morning hours was significantly different (P<0.05), decreasing from T_1 to T_3. The pH decreased from T_1 to T_3 but did not differ significantly (P>0.05). Total alkalinity was decreased from T_2 to T_1 and T_1 to T_3 but differed significantly (P<0.05). Physico-chemical parameters of the nursery ponds were more or less similar in all the treatments. Despite these variations, water quality parameters in all the experimental ponds were within the suitable range for the nursery of *L. calbasu* as in the study of Boyd (1979) (Table 1).

Table 1: Physico-chemical parameters of experimental ponds under three treatments.

Parameter	Treatment		
	T_1	T_2	T_3
Temperature (o^C)	30.82±1.90 (29.14-32.00)	30.30±2.07 (29.14-32.00)	31.02±2.88 (29.55-32.35)
Transparency (cm)	$20.66±1.46^c$ (18.80-23.66)	$24.85±1.24^b$ (23.03-27.12)	$29.88±1.31^a$ (26.44-30.22)
pH	7.88±0.17 (7.7-8.02)	7.76±0.07 (7.5-8.15)	7.64±0.17 (7.5-8.42)
Dissolved oxygen (mg/L)	5.02±0.39 (4.17-5.75)	4.84±0.50 (4.12-5.07)	4.81±0.61 (3.77-5.27)
Alkalinity (mg/L)	$136.55±5.80^a$ (133.11-138.67)	$128.22±6.43^b$ (126.13-130.77)	$122.39±7.40^c$ (120.33-125.33)

Figure in the same row having the same superscript are significantly different (P<0.05). Figure in the parenthesis indicates the range.

Transparency was consistently higher in T_3, possibly due to the reduction of the plankton population by higher density of fish (Haque *et al.*, 1994). The dissolved oxygen in the morning was low in ponds stocked with a high density of fish compared to ponds stocked with a low density. Similar results were observed by Rahman and Rahman (2003). Fluctuation of dissolved oxygen concentration might be attributed to photosynthetic activity and variation in the rate of oxygen consumption by fish and other aquatic organisms (Boyd, 1982). However, the level of dissolved oxygen (DO) is within the acceptable range in all the experimental ponds. The pH values agree well with the findings of Chakraborty *et al.* (2003). Alkalinity levels indicate productivity of the ponds was medium to high. Higher total alkalinity values might be due to higher amounts of lime doses during pond preparation and frequent liming during the experimental period (Boyd, 1982; Jhingran, 1991).

2. Plankton enumeration

The quantity of phytoplankton and zooplankton was higher in T_1 treatment where stocking density of spawn was low. The phytoplankton abundance was consistently higher than that of zooplankton. Similar results were also recorded in various food fish and fry/fingerling rearing ponds (Chakraborty *et al.*, 2003). From the Table 2, it was found that the quantity of phytoplankton and zooplankton found in treatment T_1 (342.30±57.66 and 117.12±27.37) /ml stocked at 0.60 million/ha, T_2 (304.48±53.01 and 97.57±24.11)/ ml stocked at 0.8 million/ha and T_3 (274.09±49.34 and 80.49±20.84)/ ml stocked at 1.0 million/ha respectively. Author recorded thirty genera of phytoplankton belonging to 4 groups *viz*. Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae. These are producers (Verma *et al.*, 2016). The mean abundance of total phytoplankton of T_1 was significantly higher ($P<0.05$) than those of T_2 and T_3. The zooplankton population consisted of 12 genera including nauplii in two groups *viz*. Crustacean and Rotifera. The Rotiferans were dominant over the entire experimental periods in all treatments. The abundance of zooplankton differed significantly ($P<0.05$), decreasing from T_1 to T_3. The quantity of phytoplankton and zooplankton was higher in treatment T_1 where stocking density of spawn was low. Similar results were also recorded in various food fish and fry/fingerling rearing ponds (Wahab *et al.*, 1994; Chakraborty *et al.*, 2006).

Table 2: Average variation of phytoplankton and zooplankton population under different treatments.

Plankton group	Treatment		
	T_1	T_2	T_3
Chlorophyceae	144.50 ± 8.06^a (139.34-147.20)	127.25 ± 9.12^b (124.44-130.22)	115.18 ± 10.62^c (111.24-118.22)
Bacillariophyceae	110.23 ± 8.24^a (108.45-114.20)	104.71 ± 9.74^b (102.18-171.66)	98.58 ± 8.87^c (96.34-100.61)
Cyanophyceae	78.44 ± 4.02^b (76.38-80.35)	66.44 ± 4.22^a (68.25-68.16)	55.47 ± 4.28^c (53.22-58.33)
Euglenophyceae	9.13 ± 1.12^b (7.88-10.55)	6.08 ± 0.88^a (5.28-8.02)	4.86 ± 0.65^c (3.80-5.22)
Total Phytoplankton*	342.30 ± 57.66^a	304.48 ± 53.01^b	274.09 ± 49.34^c
Rotifera	59.22 ± 2.08^a (56.44-60.28)	50.43 ± 2.26^b (49.62-48.22)	44.43 ± 2.74^c (40.28-47.32)
Crustaceae	50.02 ± 1.44^a (48.22-55.05)	42.02 ± 1.08^b (39.84-44.45)	32.24 ± 2.09^c (30.12-35.18)
Others	7.88 ± 1.02^a (6.50-9.20)	5.12 ± 1.11^b (4.15-6.11)	3.82 ± 0.82^c (2.90-4.18)
Total Zooplankton*	117.12 ± 27.37^a	97.57 ± 24.11^b	80.49 ± 20.84^c

Figure in the same row having the same superscript are significantly different ($P<0.05$). Figure in the parenthesis indicates the range. * means cell/ml×10^3) while ** means organism/ml×10^3

3. Growth, feed utilization and production

Weekly growth (length and weight) of fingerlings are shown in figures 1 and 2. The increase in length and weight was the highest in T_1 followed by T_2 and T_3. Growth and production parameters of fingerlings are shown in Table 3. The initial length and weight of spawns, stocked in all the ponds were the same. The fish in T_1 treatment showed the highest gain in both length and weight over T_2 and T_3 treatment, where stocking density of spawn was 0.60 million/ha. However, the mean final length and weight of fingerlings in different treatments were significantly different ($P<0.05$). The highest weight gain was in T_1 and lowest in T_3. SGR in T_1 was significantly higher than T_2 and T_3, and was significantly different ($P<0.05$). FCR was significantly lower in T_1 than T_2 and T_3. Therefore, SGR and FCR were best for fish in T_1 where the lowest number of hatchlings (0.60 million/ha) was reared. The highest survival rate was also observed in T_1, and the lowest in T_3. There was a significant variation ($P<0.05$) in the survival rate in *L. calbasu* fry among different treatments.

The initial length and weight of spawn stocked in all the ponds was the same, 6.50±0.01mm and 0.007±0.00g. It is evident from the data that the fry attained an average size of 76.30±0.64mm in length and 6.90±0.04g in weight in treatment T_1 with lowest stocking density of 0.60 million/ha, while the fry attained an average size of 70.67±0.55cm in length and 4.88±0.03g in weight with 0.80 million/ha density and 52.44±0.38^{c} mm in length, 3.01±0.01g in weight in T_3 with 1.0 million/ha density. This is clearly indicated that maximum growth in length and weight was attained at the lower stocking density of 0.60 million/ha with the growth gradually decreasing with increase in density, showing a negative correlation between density and growth (Fig. 1 and 2).

Table 3: Growth performance, survival and production of *L. calbasu* fry or fingerlings after six weeks of rearing under different treatments.

Parameters	**Treatment**		
	T_1	**T_2**	**T_3**
Initial length (mm)	6.50±0.01	6.50±0.01	6.50±0.04
Final length (mm)	76.30±0.64^{a}	70.67±0.55^{b}	52.44±0.38^{c}
Net length gain (mm	69.80±0.35^{a}	64.17±0.01^{b}	45.94±0.28^{c}
Initial weight (g)	0.007±0.00	0.007±0.00	0.007±0.00
Final weight (g)	6.90±0.04^{a}	4.88±0.03^{b}	3.01±0.01^{c}
Net weight gain (g)	6.893±0.3^{a}	4.873±0.2^{b}	3.003±0.1^{c}
Average daily gain (g)	0.164±0.00^{a}	0.116±0.00^{b}	0.072±0.00^{c}
Specific growth rate	1.75±0.01^{a}	1.65±0.02^{b}	1.54±0.01^{c}
Survival rate (%)	80.34±3.02^{a}	67.33±4.08^{b}	51.82±5.45^{c}
FCR	1.42±0.04^{a}	1.62± 0.03^{b}	1.88±0.04^{c}
Total Production (#)	494040±5.04^{a}	490640±7.67^{b}	501200±10.84^{c}

Figure in the same row having the same superscript are significantly different ($P<0.05$). Figure in the parenthesis indicates the range.

In this experiment, crude protein levels (32.88% dry weight) in supplementary feeds are very near the dietary protein of 31% for the optimal growth of *Labeo rohita*. Growth in terms of length, weight, weight gain and SGR of fingerlings of *L. calbasu* was significantly higher in T_1 where the stocking density was low compared to those of T_2 and T_3 although the same food was supplied in all the treatments at an equal. The causes might include competition for food and habitat due to higher density of fish (Islam, 2002; Rahman and Rahman, 2003, Chakraborty *et al.,* 2019). Fish from T_1 treatment (Table 3) had the highest average daily gain (0.164±0.00g) and specific growth rate (1.75±0.01%), respectively.

High density of fingerlings in combination with high concentration of food in the rearing system might produce a stressful situation, if not from the build-up of metabolites then from competitive interaction (Rahman and Rahman, 2003; Chakraborty *et al.,* 2003). The FCR values of T_1 treatment (1.22±0.04) are significantly lower

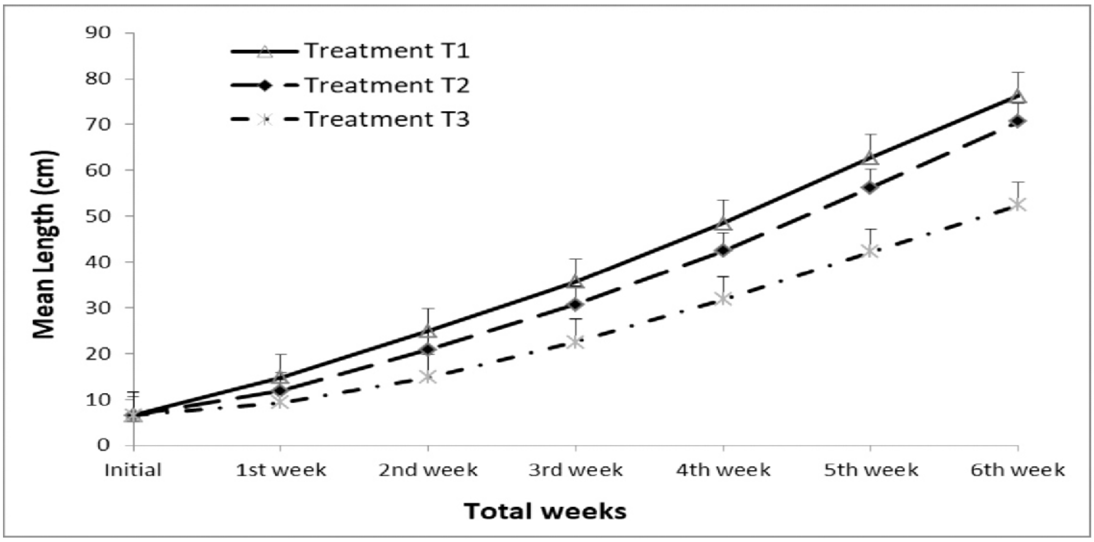

Fig.1: Weekly mean length gain (cm) of fry *Labeo calbasu* under different density.

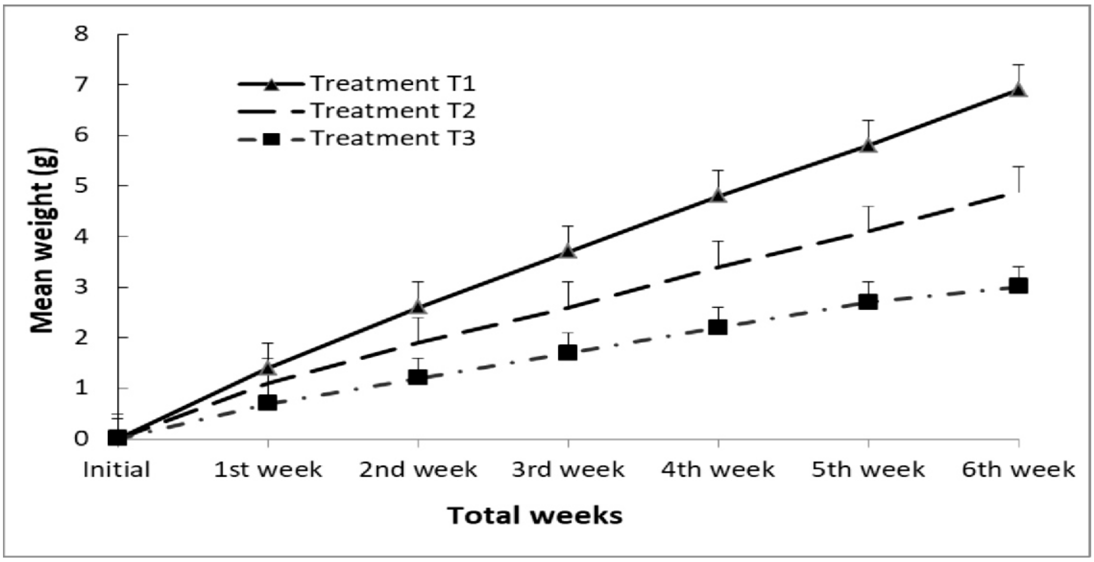

Fig. 2. Weekly mean weight (g) gain of fry *Labeo calbasu* under different density.

than those T_2 and T_3, respectively. The FCR values reported are lower than the values reported by Das and Ray (1989), Islam *et al.* (1999) and Chakraborty and Mirza (2007; 2019). De Silva and Davy (1992) stated that digestibility plays an important role in lowering the FCR value by efficient utilization of food. Digestibility, in turn, depends on daily feeding rate, frequency of feeding, and type of food used (Chiu *et al.*, 1987). However the lower FCR value in the present study indicates better food utilization efficiency, despite the values increased with increasing stocking densities.

Fingerlings of *L. calbasu* had significantly higher survival in T_1 treatment (80.34±3.02%), where the stocking density was lower than T_2 and T_3. The reason for reduced survival rate in these treatments was due to higher stocking density of fry as well as competition for food and space in the experimental ponds. Similar results were obtained by Rahman and Rahman (2003) and Chakraborty *et al*. (2003; 2006) and Chakraborty (2020; 2022) for fry/fingerlings of various carp and cat fishes.

The stocking density had a significant effect ($P<0.05$) on the growth and survival of *L. calbasu* fry. There was a significant variation ($P<0.05$) in the survival rate in *L. calbasu* fry among different treatments. Overall, highest growth and survival of fingerlings were obtained at a density of 0.60 million hatchling/ha. Growth of fingerling to a

Table 4: Cost and benefits from the nursing of *Labeo calbasu* fingerlings in 1^{-ha} earthen ponds for a nursing period of 6 weeks.

Item	Amount $TK{\cdot}ha^{-1}{\cdot}month^{-2}$			Remarks
	Treatment T_1 (Tk)[a]	Treatment T_2 (Tk)	Treatment T_3 (Tk)	
Total return (TR)[b]	444636[a]	367980[a]	275660[b]	Price is related with size and weight
a. Variable cost:				
1. Price of hatchlings (@0.22bd.tk.)	108688	107940	110264	
2. Feed 1(Tk. 20.00/kg)	40480	44640	60500	
3. Fertilizer	4512	4512	4512	
4. Human labour cost (Tk. 300.00/day)	12600	12600	12600	
5. Chemicals	3008	3208	3390	
6. Miscellaneous	4000	4000	4000	
Total Variable Cost (TVC)	173288[a]	176900[a]	195266[b]	
b. Fixed cost :				
1. Pond rental value	15020	15020	15020	Tk. 100.00/dec.
2. Interest of operating capital	17328	17690	19526	10% interest according to BKB, Bangladesh
Total fixed cost (TFC)	32348	32710	34546	
Total cost (TC= TVC+TFC)	205636a	209610a	229812b	
Gross margin (GM= TR-TVC)	271348[a]	191080[b]	80394[c]	
Net return (TR-TC)	239000[a]	158370[b]	45845[c]	

[a]1 US$ =Tk. 98.00, BKB= Bangladesh Krishi Bank
Figures with different superscripts in the same row varied significantly ($P<0.05$). Figures in the parenthesis indicate range. Sale price fingerlings Tk. 0.90/piece (T_1), Tk. 0.75/piece (T_2) and Tk. 0.55/piece (T_3).

greater extent depended on the quality and quantity of food available. In the present investigation, the amount of supplementary feeds given in different treatments was based on the number of hatchlings stocked and the amount of feed provided per fry was kept at the same level. Hence, the observed low growth at higher stocking densities could be due to less availability of natural food and some variations in environmental parameters (Chakraborty *et al*., 2003). The results in the present experiment are very similar to those of Saha *et al*. (1988), Rahman and Rahman (2003) and Chakraborty *et al*. (2006).

The mean productions (number/ha) of fingerlings were 494040 ± 5.04, 490640 ± 7.67 and

501200±10.84 in treatment T_1, T_2 and T_3 respectively. Production was higher in treatment T_3, but more or less similar production was recorded in treatment T_1 and T_2. However, production of fingerlings differ significantly ($P<0.05$) among the three treatments (Table 3). On the other hand, cost of production in treatment T_1 was consistently lower than those treatments T_1 and T_3 (Table 4). Highest benefit (gross margin, Tk./ha) was obtained in treatment T_1 (271348) followed by (191080) and T2 (80394) in that order. But highest net return (Tk./ha) was recorded in treatment T_1 (239000) followed by (158370) and T_2 (45845). This is clearly indicated that maximum growth, production and economical benefit was attained at the lower stocking density with the growth gradually decreasing with increase in density, showing a negative correlation between density and growth and production. The nursery owner may use a stocking density of 0.60 million/ha for better growth performance and survival rate of *L. calbasu* larvae during nursing stage. Production of adequate quality seeds through application of our present findings might be extremely helpful towards the protection of this important species from extinction as well as for its conservation and rehabilitation.

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REFERENCES

1. **Ali M.M., Rahman, M.M., Hossain M.Y., Rahman M.Z., Hossen M.A., Naser S.M.A., Islam R., Subba B.R., Masood Z. and Hoque M.A.** (2014). Fish Marketing System in Southern Bangladesh: Recommendations for Efficient Marketing. *Our Nature*. 12(1): 28-36. https://doi.org/10.3126/on.v12i1.12254
2. **AOAC** (1984). Association of Official Analytical Chemists. In: Howritz, W. (Ed.), Official Methods of Analysis, 14th edn. AOAC, Washington, DC. 1018 pp.
3. **Arifuzzaman M., Rahman M.H., Haque M.M. and Islam M.N.** (2022). Studies on the growth and production performance of Rohu (*Labeo rohita*) at different stocking densities in intensive aquaculture systems using floating feed. *International Journal of Biological Innovations*. 4(2): 237-246. https://doi.org/10.46505/IJBI.2022.4201.
4. **Ashok K.V.** (2017). Necessity of Ecological Balance for Widespread Biodiversity. *Indian Journal of Biology.* 4(2): 158-160.
5. **Ashok K.V.** (2018). Ecological Balance: An indispensable need for human survival. *Journal of Experimental Zoology, India.* 21 (1):407-409.
6. **Boyd C.E.** (1979). Water Quality in Warm Water Fish Ponds. Alabama Agricultural Experiment Station, Auburn, Alabama, USA, 369 pp.
7. **Boyd C.E.** (1982). Water Quality Management for Pond Fish Culture. Elsevier; The Netherlands. 318 pp.
8. **Brown M.E.** (1957). Experimental studies on growth. In: The Physiology of Fishes. (Brown, M.E. ed), Vol. I: Academic Press, New York, pp 361-400.
9. **CAMP** (1998). Conservation assessment and management plan for freshwater fishes of India. In: Workshop Report. Molur, S. and Walker, S. (eds.). Zoo Outreach Organization, Coimbatore/CBGS and NBFGR, Lucknow, India, 158 pp.
10. **Castell J.D. and Tiews K.** (1980). Report of the EIFAC, IUNS and ICES Working Group on the Standardization of Methodology in Fish Nutrition Research, Hamburg, Federal Republic of Germany, 21-23 March, 1979, EIFAC Tech. Pap., 26p.
11. **Chakraborty B.K.** (2020). Rearing and Nursing of Thai Pangas, *Pangasianodon hypophthalmus* (Sauvage, 1978) with different feeds. *International Journal of Biological Innovations*. 2 (2):277-286. https://doi.org/10.46505/IJBI.2020.2224
12. **Chakraborty B. Kumar** (2021). Induction of spawning and nursing pangas, *Pangasianodon hypophthalmus* (Sauvage, 1878) under hatchery system. *International Journal of Biological Innovations.* 3 (2): 264-270. https://doi.org/10.46505/IJBI.2021.3203

13. **Chakraborty B.K.** (2022). Effect of stocking density on growth and survival of endangered *Mystus bleekeri* (Day, 1877) in nursery system. *International Journal of Biological Innovations*. 4(2): 299-308. https://doi.org/10.46505/IJBI.2022.4206.

14. **Chakraborty B.K. and Mirza M.J.A.** (2007). Effect of stocking density on survival and growth of endangered bata, *Labeo bata* (Hamilton-Buchanan) in nursery ponds. *Aquaculture*. 265: 156-162. https://doi.org/10.1016/j.aquaculture.2007.01.044

15. **Chakraborty B.K. and Mirza M.J.A.** (2009). Effect of stocking density on survival and growth of endangered Kuria labeo, *Labeo gonius* (Hamilton-Buchanan, 1822), in nursery ponds. *Bangladesh Journal of Life Science*. 22(1): 25-133.

16. **Chakraborty B.K. and Mome M.** (2022). Status of aquatic resources and production of Kongsha River in northern Bangladesh. *International Journal of Biological Innovations*. 4(1): 01-15. https://doi.org/10.46505/IJBI.2022.4101.

17. **Chakraborty B.K., Bhattacharjee S. and Muniya S.** (2021a). A Study on Aquatic Biodiversity of Shuthi-Shaiduli River of Bangladesh. *International Journal of Biological Innovations*. 3 (1): 58-67. https://doi.org/10.46505/IJBI.2021.3104

18. **Chakraborty B.K., Miah M.I., Mirza M.J.A. and Habib M.A.B.** (2003). Rearing and nursing of local sarpunti, *Puntius sarana* (Hamilton) at different stocking densities. *Pakistan J. of Biological Sci*., 6:797-800. 10.3923/pjbs.2003.797.800

19. **Chakraborty B.K., Miah M.I., Mirza M.J.A. and Habib M.A.B.** (2006). Rearing and nursing of endangered sarpunti, *Puntius sarana* (Ham.) with three supplementary feeds. *J. Asiat. Soc. Bangladesh Sci*. 32(1):33-41.

20. **Chakraborty B.K., Shahroz M.H., Bhuiyan A.B., Bhattacharjee S. and Chattoraj S.** (2019). Status of Indian major carps spawns in the Halda River along with marketing and economic condition of the Fishers and related collectors. *International Journal of Biological Innovations*. 1 (2):40-50. https://doi.org/10.46505/IJBI.2019.1202

21. **Chakraborty B.K., Verma A.K. and Muniya S.** (2021b). Present Status of Aquatic Resource and Its Catch of Mogra River in Bangladesh. *Sustainable Marine Structures*. 3 (2): 26-38. http://dx.doi.org/10.36956/sms.v3i2.436

22. **Chiu Y.N., Sumagaysay N.S. and Sastrillo M.G.S.** (1987). Effect of feeding frequency and feeding rate on the growth and feed efficiency of milk fish, *Chanos chaqnos* (Forskal) Juveniles. *Asian Fish. Sci*. 1: 27-31.

23. **Chondar S.L.** (1999). Biology of Finfish and Shellfish. SCSC Publishers, India, 514 pp.

24. **Clesceri L.S., Greenberg A.E. and Trussell R.R.** (1989). Standard Methods of the Examination of Water and Wastewater (17th ed.). American Public Health Association, American Water Works Association and Water Pollution Control Federation, 1015 Washington D.C., USA 20036, 10-203.

25. **Das I. and Ray A.K.** (1989). Growth performance of Indian major carps *Labeo rohita* (Ham.) on duckweed incorporate pelleted feed: a preliminary study. *J. Inland Fish*. 21(1):1-6.

26. **De Silva S.S. and Davy F.B.** (1992). Fish nutrition research system in Asia. *Asian Fisheries Science*. 5(2):129-144.https://doi.org/10.33997/j.afs.1992.5.2.001

27. **Duncan D.B.** (1955). Multiple range and multiple *F*-testes. *Biometrics*.11:1-42.

28. **Dwivedi A.C., Tewari N.P. and Singh K.R.** (2004). Present structure of capture and culture fishery of the Faizabad district (U.P.). *Bioved*. 15: 95-98.

29. **Gangadhara B., Nandeesha M.C., Varghese T.J. and Keshavanath P.** (1997). Effect of varying protein and lipid levels on the growth of Rohu, *Labeo rohita*. *Asian Fish. Sci*. 2: 139-147.

30. **Gupta S. and Banerjee S.** (2014). Indigenous ornamental fish trade of West Bengal. Narendra Publishing House, New Delhi, 63 pp.

31. **Gupta S., Dutta D. and Banerjee S.** (2012). Changing trend in ornamental fish markets of Kolkata, West Bengal, India. *Fishing Chimes*. 32(9): 61-63.
32. **Haldar R., Hossen S., Hossain M.M., Ali M.M., Roy P., Saha N., Hossain M.B., Mahmud A. and Shadin M.K.S.** (2020). Fish Availability and Marketing System of a Fish Market in Manikganj, Bangladesh. *World Journal of Fish and Marine Sciences*. 12(1): 16-23. 10.5829/idosi.wjfms.2020.16.23
33. **Hamilton F.** (1822). An account of the fishes found in the River Ganges and its branches. Archibald Constable and Company, Edinburg. 405 p.
34. **Haque M.Z., Rahman M.A., Hossain M.M. and Rahman M.A.** (1994). Effect of stocking densities on the growth and survival of mirror carp, *Cyprinus carpio* var. *specularis* in rearing ponds. *Bangladesh J. Zool*. 22: 109-116. 10.3329/ajmbr.v2i3.30114
35. **Islam A.K.M.S., Hossain M.M.M. and Chakraborty B.K.** (1999). Growth performance of mirror carp fry fed on different supplementary diets. *Bangladesh J. Train. and Dev*. 12: 161-165.
36. **Islam Md. Shahidul** (2002). Evaluation of supplementary feeds for semi intensive pond culture of Mahaseer, *Tor putitora* (Hamilton). *Aquaculture*. 212(1-4): 263-276. https://doi.org/10.1016/S0044-8486(02)00194-1
37. **IUCN Bangladesh** (2000). Red book of threatened fish of Bangladesh. The world conservation Union Appendix 1, 61 p.
38. **Jhingran V.G.** (1991). Fish and Fisheries of India, 3rd edn. Hindustan Publishing Corporation Delhi, India. 727 pp.
39. **Jhingran V.G. and Pullin R.S.V.** (1985). A hatchery manual for the common carp, Chinese and Indian majors carps. ICLARM studies and reviews, III: 191p.
40. **Mollah M.F.A.** (1985). Effects of stocking density and water depth on growth and survival of fresh water cat fish (*Clarias macrocephalus*) larvae. *Indian J. Fish*. 32: 1-17.
41. **Moyle P.L. and Leidy R.A.** (1992). Loss of biodiversity in aquatic ecosystem: Evidence from Fish Fauna. In P. L. Fielder and H.L. Jani (eds). Conservation of biology: the theory and practice of nature conservation, preservation and management. Chapman and Hall, New York. 562p.
42. **Nautiyal P., Shivam A., Rawat G., Singh K.R., Varma J. and Dwivedi A.C.** (2004). Longitudinal variation in structure of benthic communities in the upland Vindhyan and Himalayan: River continuum concept approach. *National Journal of Life Sciences* 1: 85-88.
43. **Pathak S.C. and Jhingran A.G.** (1977). Maturity and fecundity of *Labeo calbasu* (Ham.) of Loni reservoir, Madhya Pradesh, India. *Journal of Inland Fisheries Society of India*. 9:72-83.
44. **Prakash Sadguru and Verma A.K.** (2022). Anthropogenic activities and Biodiversity threats. *International Journal of Biological Innovations*. 4(1): 94-103. https://doi.org/10.46505/IJBI.2022.4110.
45. **Rahman A.K.A.** (2005). Freshwater fishes of Bangladesh. Zoological Society of Bangladesh, Dhaka, Bangladesh, 263 pp.
46. **Rahman M.R. and Rahman M.A.** (2003). Studies on the growth, survival and production of calbasu (*Labeo calbaus* Ham.) at different stocking densities in primary nursing. *Bull. Fac. Sci., Unv. Ryuyus, Jpn*. 76: 245-255.
47. **Rahman M. Shahidur** (1992). Water quality management in Aquaculture BRAC Prokashana, Dhaka, Bangladesh. 84 pp.
48. **Saha S.B., Gupta M.V., Hossain M.G. and Shah M.S.** (1988). Growth and survival of rohu (*Labeo rohita*) fry in rearing ponds at different stocking densities. *Bangladesh J. Fish*. 16: 119-126.
49. **Stirling H.P.** (1985). Chemical and Biological Methods of Water Analysis for Aquaculturist. Institute of Aquaculture, University of Stirling, Scotland, UK., 119 pp.
50. **Talwar P.K. and Jhingran A.G.** (1991). Inland fishes of India and adjacent countries. Oxford

and IBH Publishing Co. PvT. Ltd., New Delhi, India. 2: 541 pp.

51. **Verma A.K. and Prakash S.** (2020). E-wastes and their impact on environment and public health. *International Journal of Applied Research*. 6(9): 164-168.

52. **Verma A.K. and Prakash Sadguru** (2022). Microplastics as an emerging threat to the fresh water fishes: A review. *International Journal of Biological Innovations*. 4(2): 368-374. https://doi.org/10.46505/IJBI.2022.4212.

53. **Verma A.K., Prakash S. and Mishra B.K.** (2016). Phytoplankton diversity in Alwara lake of district Kaushambi (U.P.). *Journal of Entomology and Zoology Studies*. 4(1): 170-172.

54. **Wahab M.A., Ahmed Z.F., Haq M.S. and Begum M.** (1994). Compatibility of silver carp in the polyculture of cyprinid fishes. *Progress. Agric*. 5: 221-227.

55. **Zar J. H.** (1984). Biostatistics. Prentice-Hall, Inc. Englewood Cliffs, New Jersey, USA, 718 pp.