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A Comparative Study on the Growth and Mortality of Rohu fish, *Labeo rohita* of the Halda River (Wild) and Induced Hatchery (Artificial) Sources

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Abstract

The growth and mortality rates of *Labeo rohita* from the Halda River strain and the hatchery strain were studied under identical water quality and environmental conditions to identify the better performer. 250 Rohu fish fries from the Halda River and the hatchery were reared for this experiment. The rearing trial was performed for 14 weeks in 12 m^3 net cages, each with three replica sets in an earthen pond. Fishes were sampled weekly for measuring body weight and length. The final mean weight was significantly higher in the Halda strain (57.46 ± 22.91 g) compared to the hatchery strain (24.20 ± 7.61 g) ($p < 0.05$), with weight gain in the Halda strain more than twice that of the hatchery strain. In most sampling stages, the growth rate of *Labeo rohita* was significantly higher ($p < 0.05$) in the Halda strain. The final mean length was also greater in the Halda strain (13.07 ± 1.63 cm) compared to the hatchery strain (10 ± 1.08 cm). Mortality rates were lower in the Halda strain (15.60%) than that of the hatchery strain (31.20%) over the 14 weeks. These findings suggest that the Halda strain significantly outperforms the hatchery strain in growth and survival under controlled conditions.

Keywords: Indian Major Carps (Rohu), Halda River strain, hatchery strain, growth rate, mortality rate

Introduction

Fish and fisheries play a crucial role in Bangladesh's social and economic life by providing employment, foreign exchange earnings, nutrition, and income. Approximately 60% of the country's animal protein consumption is sourced from fish. In 2017-18, fish product exports contributed 3.57% to the GDP and 1.5% to foreign exchange earnings[5]. Bangladesh is the world's third-largest aquacultural producer, with an estimated production of 1.25 million tons in 2020, accounting for 11% of global fish production[8]. The Halda River in Bangladesh holds significant importance in fish production and is known for the natural collection of fertilized eggs of Indian Major Carps, including Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus cirrhosus*), and Kalibaush (*Labeo calbasu*)[18, 22]. The pond carp culture in the country is largely dependent on naturally bred fish fry from the Halda River, which is greatly valued for its economic and nutritional advantages. As much as 60% of the country's fish ponds use this source of fish fry for carp culture[12]. The Indian Major Carp fries from the Halda River are highly sought after by fish farmers, commanding a market value significantly higher than that of other sources. In Bangladesh, there are 926 hatcheries, both public and private, which account for 99% of the country's spawn production using induced breeding[5]. These hatcheries prioritize quantity and pay little attention to quality and a similar situation in India

was discussed regarding the spawn production of major carps[6]. On the other hand, a thriving fish cultivation sector requires genetically superior fish seed. The production of high-quality fish seed is essential for a successful fish farming industry. In Bangladesh's fisheries sector, there has been a considerable debate regarding the diminishing quality of seedlings generated in hatcheries[19].

However, the better growth rate and survival of Halda's Indian Major Carp compared to other sources have been observed, but there is no strong scientific evidence to support the claims of high growth and low mortality rates of these fish, which raises questions about the worthiness of their high market value. Thus, this research aims to scientifically compare the growth and mortality rates of Indian Major Carp, Rohu (*Labeo rohita*) of Halda River brood stock and hatchery stock produced by induced breeding under the same water quality and environmental conditions. The research will explore how transparent the commercial exchange is and suggest potential strategies to regulate market prices more effectively as the fish farmers will have their right to choose the economically feasible strain to culture.

Materials and Methods

Site Selection

This study was conducted at a selective site adjacent to the Halda River in the Chittagong Division of Bangladesh from July-October 2023. This place is named as IDF Halda Research and Training Center, West Binajuri, Raojan, Chattogram (22.499164^0 N, 91.873578^0 E) (Figure 1). The research involved selecting two circular cisterns that have an artificial water circulation system, each having a depth of 1 meter. Additionally, a large pond of (45m ×30m) =1350 m^2 was selected. The experimental growth trial was conducted for 14 weeks.

Pond preparation

Before stocking fish in the pond, certain preparations were done. Rotenone was applied to eliminate unwanted fish species, harmful insects or predators and to restore the ecological balance of the pond. Quicklime (700 kg/ha) was also applied to the pond to achieve optimum water pH levels. Finally, NPK fertilizers (100 kg/ha) were used as needed to promote the growth of natural food for the fish[7] and no artificial food was provided during the experiment.

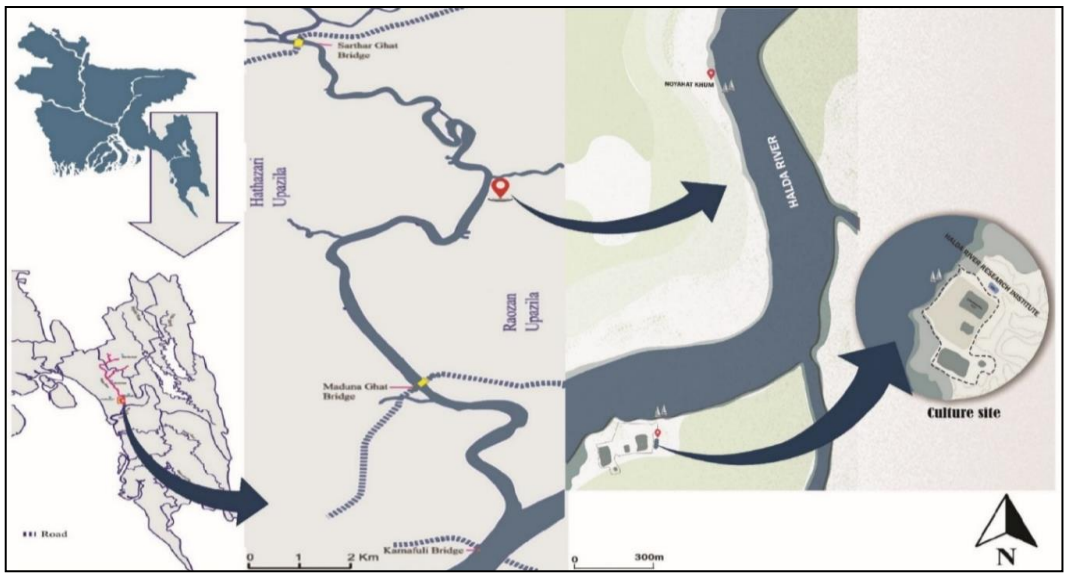

Figure 1: Map of the experimental site

Net cage making and set-up

Net cages were constructed with fine-meshed (20 mm) nylon net and rope which was sewed together to form a rectangular enclosure. Net cage looks like an inverted mosquito net and is often used for fingerling rearing. Each net cage was 5 m×2 m =10 m^2 in size while the height of the cage was 1.2 m. The net cages were fixed with bamboo poles and floating drums. To avoid clogging net cages were cleaned once a week[13].

Seed collection

Fries of *Labeo rohita* were collected from two sources, Halda River, and a commercial hatchery named Chattogram Hatchery, Charia, Hathazari, Chattogram and it was ensured that they are of the same age and of same species.

Experimental design

Rohu fries were reared in two cisterns with artificial circulation to minimize mortality and to ensure close observation. When the early fries developed into advanced fries, they were transferred to an experimental plot. Six net cages of the same size were launched into a large pond for each group. Two extra cages were used to tackle any unwanted events as well as relocate the fish during the cleaning process.

Stocking of fish

At a rate of 25/m^2 fries of *Labeo rohita* were collected from Halda River and hatchery were stocked in each net cage[1]. No artificial feed was provided.

Growth parameters

The length and weight of fish were measured using a centimeter-scale and electric balance (Model; HKD-620AS-Led) in grams. The following parameters were used to monitor the growth during sampling and after harvesting. Initial weight (g), final weight (g), weight gain (g), Initial length (cm), final length (cm), length gain (cm), specific growth rate (SGR%), condition factor (CF) and mortality (%) were calculated by using the following equations:

Initial weight (g) = Weight of fish at stock;

Final weight (g) = Weight of fish at harvest;

Weight gain (g) = Mean final weight- Mean initial weight;

Initial length (cm) = Length of fish at stock;

Final length (cm) = Length of fish at harvest;

Length gain (cm) = Mean final length- Mean initial length;

Specific Growth Rate, SGR (%) = $\frac{\ln W2 - \ln W1}{\text{time (days)}} \times 100$;

where, W1 and W2 indicate the initial and final weight (g), respectively.

Condition Factor, CF = $\frac{W}{L^3} \times 100$;

where, W= wet body weight (g) and L= body length (cm).

Mortality = $\frac{No.of\ dead\ fish}{Total\ number\ of\ fish\ stock} \times 100$

Water quality parameters

To maintain the quality of the pond's water at an acceptable level, chemical parameters such as dissolved oxygen (DO) were monitored regularly by using HACH multi-parameter HQ (40d). Water temperature, turbidity, pH etc. were recorded by using Celsius thermometer, HACH turbidity meter (2100Q), and HANNAH pH meter (HI98107) respectively.

Statistical analysis

All the experimental data were tested using one-way analysis of variance (ANOVA) following Microsoft Excel software (version 2016) for Windows. The average value of each net cage was treated as an independent value and a grand mean ± SE was estimated from triplicate hapas per treatment for growth and associated parameters. Significant differences were calculated by independent t-test at 5% level of significance ($p < 0.05$).

Results and Discussion:

Pond water quality

Parameters like pH, temperature dissolved oxygen (DO), and water turbidity were recorded fortnightly throughout the study period. The pH (7.0-8.0), temperature (28-33°C), DO (5.5-7.5 mg/l), and Secchi depth (25-30 cm) of water were found within suitable ranges for each treatment during the experiment.

Growth performance of *Labeo rohita*

Final weight

The initial weight of individual fries was 0.10±0.026g and 0.11±0.008g for Halda and hatchery strain respectively (Table 1). The final mean weight of each fish was 57.462±22.906g for Halda and 24.204±7.607g for hatchery respectively with significant difference ($p<0.05$) between the treatments (Figure 2).

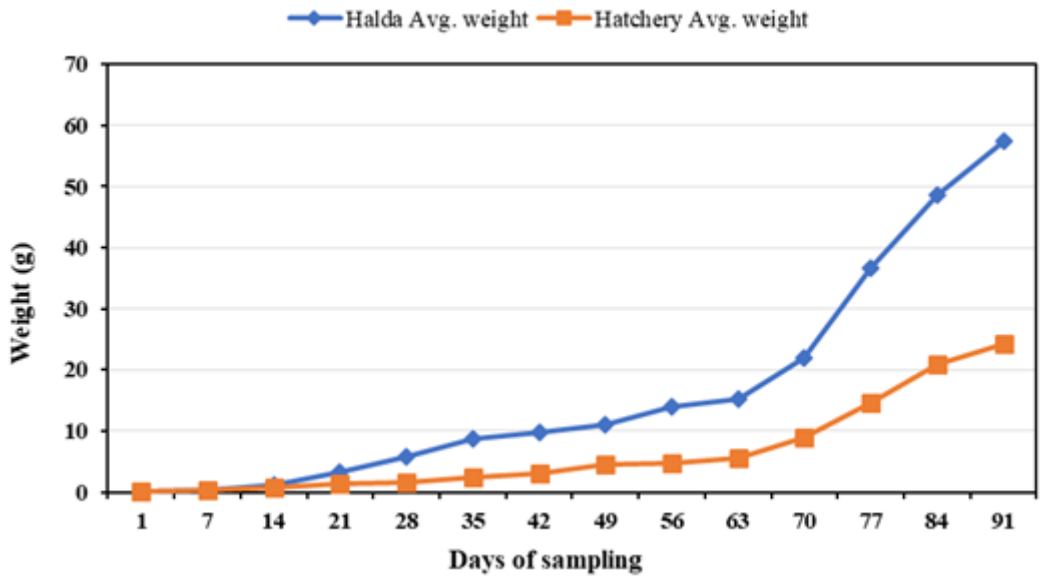

Figure 2 : Weight comparison of Halda and Hatchery strains

Weight gain

The average weight gain for the Halda strain was 57.359±22.88g and for hatchery strain it was 24.093±7.662g (Table 1). The weight gain of fries was more than two times higher in the Halda strain than that of the hatchery strain. In terms of weight gain, in most sampling stages, the performance of the Halda strain was significantly ($p<0.05$) higher in comparison to hatchery strain.

Final length

The initial length of individual Rohu fries was 2.411±0.309 cm and 2.677± 0.114 cm for Halda and hatchery strains respectively (Table 1). The final mean length of each fish was 13.067±1.632 cm for Halda and 10±1.076 cm for hatchery, respectively with significant differences ($p <0.05$) between the treatments (Figure 3).

Length gain

The average length gain for the Halda strain was 10.656±1.323 cm and for the hatchery strain it was 7.323±0.962 cm, respectively (Table 1). In terms of length gain, in most sampling stages, the performance of the Halda strain was significantly ($p<0.05$) higher than that of the hatchery strain.

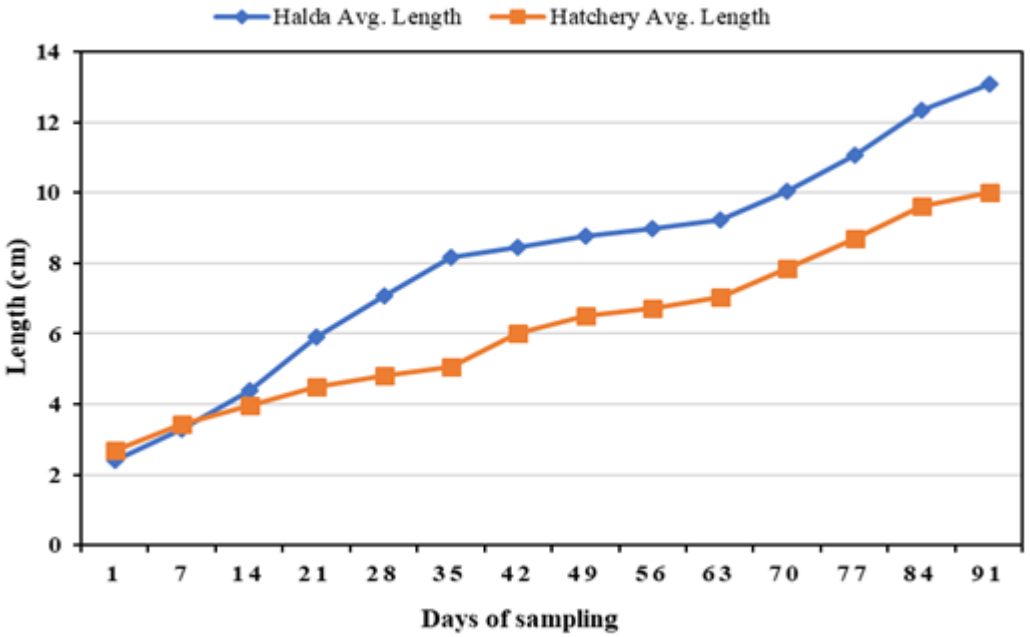

Figure 3 : Length comparison between Halda and Hatchery strain

Specific Growth Rate (SGR%)

The specific growth rates (SGR) of Rohu fries from Halda and hatchery were found to be 6.945±0.506 and 5.836±0.324 respectively (Table 1). There was significant difference ($p<0.05$) in terms of SGR between the strains of these two sources.

Condition Factor (CF)

The CF value of Halda strain was 1.778±0.341 and for hatchery strain the same was 1.578±0.310 (Table 1) and it indicates that there was a significant difference with ($p<0.05$) Halda strain in terms of Condition factor.

Mortality

Mortality rate was almost double in the hatchery strain (Figure 4). In the Halda strain, mortality was 15.6% in 14 weeks whereas, 31.2% was seen in the hatchery fishes (Table 1).

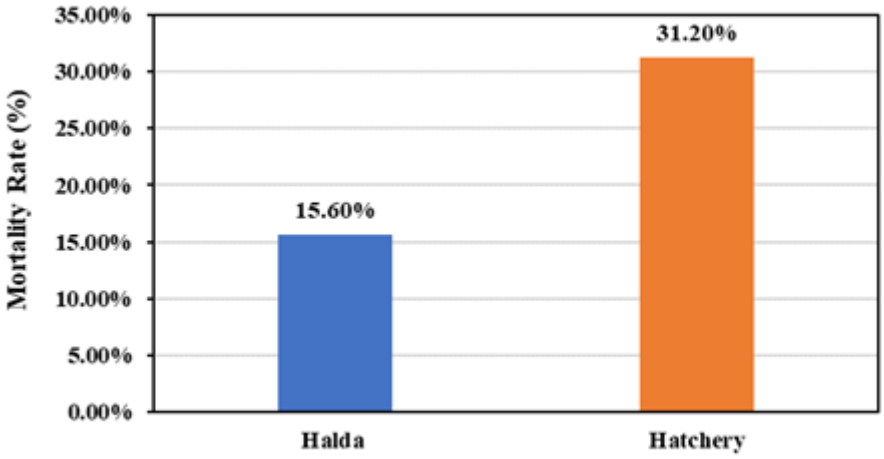

Figure 4: Comparison of Mortality Rate between the Halda and Hatchery strain

Table 1: Growth performance of *Labeo rohita* from two different sources

Parameters	Halda	Hatchery
Initial weight (g)	0.10 ± 0.026	0.11 ± 0.008
Final weight (g)	57.462 ± 22.906	24.204 ± 7.607
Weight gain (g)	57.359 ± 22.88	24.093 ± 7.662
Initial length (cm)	2.411 ± 0.309	2.677 ± 0.114
Final length (cm)	13.067 ± 1.632	10 ± 1.076
Length gain (cm)	10.656 ± 1.323	7.323 ± 0.962
SGR (%)	6.945 ± 0.506	5.836 ± 0.324
CF	1.778 ± 0.341	1.578 ± 0.310
Mortality (%)	15.60	31.20

Analysis has been performed to examine the rate of growth and mortality of Indian Major Carps, Rohu (*Labeo rohita*) obtained from Riverine source Halda and induced breeding source hatchery. The data was collected over 14 weeks from July to October. The water quality was similar to that of previous studies on Indian major carp (Manam and Quraishi, 2024). To evaluate the overall growth condition, the Specific Growth Rate (SGR) was calculated during this time. The Condition Factor (CF) was examined to assess the well-being of the fish. Furthermore, regular fish fatalities were documented to determine the mortality rate.

Throughout the 14-weeks study, the initial lengths of Indian major carps, Rohu were 2.411 ± 0.309 cm and 2.677 ± 0.114 cm for the Halda and hatchery strains respectively (Table 1). There was no significant difference observed between the two groups ($p > 0.05$). By the end of the experiment, the Halda strain exhibited a significantly greater final length of 13.067 ± 1.632 cm compared to 10 ± 1.076 cm for the hatchery strain (Table 1) ($p < 0.05$). The initial weights were 0.10 ± 0.026 g for Halda and 0.011 ± 0.008 g for the hatchery strain (Table 1), showing no significant difference ($p > 0.05$). However, the final mean weights were significantly higher for the Halda strain viz., 57.462 ± 22.906 g compared to 24.204 ± 7.607 g for the hatchery strain (Table 1). There is a significant difference between the two strains ($p < 0.05$).

The specific growth rate (SGR) is a measure of growth relative to the initial size or weight of the fish, usually expressed as a percentage per unit of time, typically of per day. SGR allows for comparisons of growth rates among individuals or populations with different starting sizes or weights, and it generally decreases as the organisms grow larger[15, 21]. In the present study, the SGR for *Labeo rohita* from Halda were 6.945 ± 0.506%, while the hatchery strain had an SGR of 5.836 ± 0.324%, indicating a significantly ($p < 0.05$) higher growth rate in Halda strain (Table 1). So, it is seen that the specific growth rate is lower in the hatchery strain compared to Halda strain.

The condition factor serves as a crucial biological parameter, indicating the suitability of a particular water body for fish growth and as an indicator of the average size of the species[2]. Previous study suggests that

condition factor values greater than 1 (one) indicates good fish health[16], while values between 1.4-1.6 are considered good and above 1.6 are excellent[9]. In this study, the CF value for Halda strain was 1.778 ± 0.341 compared to 1.578 ± 0.310 for the hatchery strain, as shown in Table 1, indicating that Halda strains are in health condition relative to their length than the hatchery strain and have a significant difference at 5% significance level ($p < 0.05$) for Halda strain. The higher CF in the riverine strain than the hatchery-originated strain suggested that the riverine strain was in good condition which, in turn, resulted in higher growth performance[4].

The fish's death rate was not influenced by any external factors, as the water quality and other parameters were consistent for both treatments. The mortality rate for the Halda strain stood at 15.6%, while it was more than double for the hatchery strain, at approximately 31.2% (Table 1). The lower observed survival rate and higher mortality rate of hatchery seed provide indications of inbreeding in the population, as evidenced by the studies[10, 17].

In the present study, the growth performance of *Labeo rohita*, one of the Indian major carps, was found to be better in the Halda strain when compared to the growth of the same fish in hatchery conditions. A similar pattern of growth was also documented in Indian major carp[3]. In a genetic population analysis[11], found that the Halda river fish population exhibited higher quality compared to the same populations from any other origins in Bangladesh.

Conclusion

The findings of this study demonstrated that Halda strain seedlings outperform hatchery strain seedlings in growth performance. The inferior growth of hatchery strains is likely due to poor management practices, the use of smaller and fewer brood fish, and lack of genetic diversity maintenance. Addressing these issues through improved hatchery practices and international research collaborations could help preserve the valuable populations of genetically improved Indian major carps.

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