***Original Research Article***

**Performance Evaluation of Growth Parameters for *Mystus cavasius* (Hamilton-Buchanan, 1822) in Relation to Different Stocking Densities cultured in a FRP Tank**

**ABSTRACT**

The present study was undertaken to develop a practical and economically viable methodology for mass seed production and rearing of *M. cavasius* in a controlled management system for getting maximum production. This three-month monoculture study investigated the impact of varying stocking densities on the growth performance, survival, and water quality parameters of *Mystus cavasius*. The study was conducted from April-June, 2023. A Complete Randomization Design (CRD) was employed, utilizing three distinct stocking densities: 100 individuals/decimal (T1), 150 individuals/decimal (T2), and 200 individuals/decimal (T3), each with two replications.Fortnightly, measurements were taken for key water quality parameters including temperature, dissolved oxygen (DO), pH, and transparency. The results revealed significant differences (P < 0.05) between the treatments across these parameters and growth performance. Notably, the highest length and weight were observed in the T1 treatment while the lowest stocking density (T1) yielded a superior growth rate coupled with maximum survivability. In conclusion, these findings suggest that a comparatively lower stocking density for *Mystus cavasius* in enclosed culture systems not only enhances production but also contributes to the maintenance of optimal water quality parameters.

**Keywords:** *Mystus cavasius*, growth performances, survival rate and water quality parameters

1. **INTRODUCTION**

Aquaculture has gained prominence in rural India as a strategy for achieving self-reliance and poverty alleviation (Al -Amin *et al*., 2012, Roy *et al*., 2021). India is home to four recognized biodiversity hotspots, one of which is **North-East India**, internationally acknowledged for its exceptional biodiversity. This region features a range of ecosystems, from the **Himalayan foothills** to the vast **Brahmaputra plains**, supporting a diverse array of flora and fauna, including a substantial number of fish species. As noted by **Sen (2003)**, a total of **291 fish species**, both indigenous and exotic, have been recorded in North-East India. These species belong to **38 families** and **12 orders**, highlighting the region’s rich ecological diversity and the variety of its aquatic environments. North Eastern India is globally acknowledged as a freshwater biodiversity hotspot, hosting 422 fish species across 133 genera and 38 families (Munilkumar*et al*., 2007). As per the findings of Bhattacharjya*et al*. (2004), Assam has the highest diversity of finfish species in the region, with a total of 216 species. Of these, 52 species (33.33%) are particularly significant for their economic value as food fish. It is estimated that out of the 216 fish species in Assam, 34 species have a market demand greater than that of the Indian major carps, while 19 species hold similar economic value. Despite the state's vast potential for diversifying fish species in aquaculture, it continues to rely predominantly on carp culture (more than 95% of aquaculture production) due to the lack of seed production technology for indigenous finfish species. This reliance on carp culture persists, limiting the broader diversification of fish farming practices in the region.

*Mystuscavasius* (Hamilton-Buchanan, 1822), commonly known as the Gangetic mystus, is a catfish species belonging to the order Siluriformes and the family Bagridae. This species exhibits a wide distribution across South and Southeast Asia, including India, Bangladesh, Pakistan, Nepal, Sri Lanka, Thailand, and Myanmar(Talwar &Jhingran, 1991; Tripathi, 1996; Rahman *et al*., 2004; Chakrabarty & Ng, 2005). *M. cavasius* is a small indigenous catfish (SIS) predominantly found in freshwater ecosystems such as rivers, canals, beels, wetlands, ditches, and seasonally inundated fields, and has also been reported in floodplains, swamps, tidal rivers, and lakes. It is a highly favored food fish among consumers, commanding significant market demand and a moderate price. The species is recognized for its high flesh protein content. Furthermore, *M. cavasius* has recently been classified as an ornamental fish and is considered a native aquarium species originating in India (Siddiqui *et al*., 2010; Ashashree*et al*., 2013; Gupta & Banerjee, 2014).

In recent years, significant changes to aquatic ecosystems have occurred due to flood control measures and human activities. These include the reduction of water bodies, siltation, and erosion of river basins, which have disrupted habitats and breeding grounds for many species (Hussain & Mazid, 1999). Additionally, excessive pesticide use in agriculture and chemical discharges from industries have further polluted water bodies, degrading water quality and harming aquatic life. The silurid catfish, a species of ecological and economic importance, has been particularly affected, with its population declining due to habitat loss and environmental degradation. Immediate conservation efforts are needed to prevent its extinction (Hussain & Mazid, 1999). Considering the erratic weather condition due to climate change, and fluctuating water table due to seasonal variability in the pond aquaculture system, the culturing of small indigenous fin fish (SIFF) is gaining momentum due to its survivability in small water table and its nutritious value. *Mystuscavasius* is a small indigenous finfish (SIFF) found in most of the water bodies ranging from pond, canal, wetlands and rivers etc. *Mystuscavasius* is small indigenous fish species (SIS) with a high nutritional value that includes protein, micronutrients, vitamins, and minerals. Due to their delicacy and protein-rich contents, these fish are highly preferred by consumers and in high demand in Bangladesh and eastern India. Furthermore, it has recently been classified as an ornamental fish and is considered a native aquarium species originating in India. Overexploitation and other ecological changes that negatively impact the species’ natural habitat have caused the natural population to decline, (Hanafie *et al*., 2023; Konan *et al*., 2021). The species fetch very good price in domestic market both in live condition and as value added fish products. Owing to its market value, the pressure on wild collection of this species is increasing at a faster rate. To reduce the pressure on the wild population of *M. cavasius,* it is the need of the hour to carry out scientific study on its reproductive biology and develop an artificial breeding protocol of the species to ensure its viability in the nature.

This research paper aims to brood stock development for *M. cavasius* to maximize fertilization, hatching, and survival rates in captive-bred *M. cavasius*. The development of such protocols will be a significant contribution to the sustainable aquaculture of this valuable species and play a crucial role in its long-term conservation. For brood stock development it would be necessary to maintain appropriate stocking densities for optimum growth, survival and production of fingerlings. Both positive and negative relationships between stocking density and growth have been reported and the pattern of this interaction appears to be species specific (Trzebioatowski, Filipiak & Jakubowski 1981; Carro-Anzalota& McGinty 1986; Kaiser, Weyl & Hecht 1995; Canario, Condeca& Power 1998; Rahman, Mazid, Rahman, Khan, Hossain & Hussain 2005; Chakraborty & Mirza 2007). No study has yet been undertaken on stocking density of gulsha for rearing in FRP tank. The present study has therefore been undertaken to develop a practical and economically viable methodology for mass seed production and rearing of *M. cavasius* in a controlled management system for getting maximum production.

1. **MATERIALS AND METHOD**

**Experimental design:**

This research was carried out in the College of Fisheries, AAU, Raha from April to June 2023. The healthy wild population of *M. cavasius* will be collected from open water bodies of Assam. The One-month-oldfish about 3 cm long and 2 g in weight will be treated with 0.5% KMnO4before they rear in FRP tank of 5000L capacity and around six feet water depth was maintained throughout the study period. The different rearing system will be used to observe its better survivability in different system. Three different treatments viz., 100 nos/m3 (T1), 150nos/ m3(T2) and 200nos/ m3(T3) were stocked with three replicates of each treatment

**Fish Feed**: The experimental fish will be fed with brood feed containing 40% crude protein (CP) and 6 % crude lipid (CL) as reported by Abidin *et al*. (2006) and Begum *et al*. (2008). Semi solid feed will be prepared with locally available ingredients such as animal and plant protein sources preferably poultry offal and agricultural waste. The ingredients will be collected from the local market followed by proper grinding and sieving of the ingredients. All the practical ingredients will be thoroughly mix with water (70% W/V) to make dough and steam cooked in a pressure cooker for half an hour. Additives, oil and vitamins mineral mixture (Emix Plus) will be incorporated into the dough after cooling. The semi solid feed will be labelled according to the treatments and will be stored at 4°C until use.

**Water quality parameters:**

Three physico-chemical parameters of tank water were recorded *viz*., temperature, dissolved oxygen and pH were measured with an interval of 7 days during the whole period of study. In present study, temperature and dissolved oxygen were measured by using mercury-in-glass thermometer and a dissolved oxygen meter (YSI model 58, USA), respectively. The water pH was measured by using portable pH meter (CORNING model 445).

**Growth parameters:**

Growth in terms of length and weight, Average daily gain (ADG), Specific Growth Rate (SGR) and Food conversion rate (FCR) was estimated. SGR and FCR were calculated according to Brown (1957); Castell and Tiews (1980) and Gangadhara *et al.* (1997). After 15 days of interval 20 fishes from each tank were randomly harvested with the help of seine net from 1st April to 30th July 2015 in order to measure the length and weight gain of fishes using the following formulas -

**Total length:** The length of fish (tip of the snout to the edge of caudal fin) was measured with the help of measuring scale and board.

**Weight gain:** Weight gain (W) was calculated as, W = W2 – W1, where, W1 is initial weight and W2 is final weight.

**Specific growth rate:** Specific growth rate of fish under different treatments was calculated using the following formula –

SGR (%)= In W2-InW1/T X 100

Where, InW2 – **InW1** is the difference of logarithm of initial and final weight and T is the duration of the experiment (days).

**Survival rate:** The survival rate (SR) of fish was calculated as follows:

SR= Final total number of fish/ Initial total number of fish X100

**Average daily gain (g)** = (mean final weight-mean initial weight)/time interval (days)

**FCR (Food conversion ratio)** = Total diet fed (kg)/ total wet weight gain (kg)

**Statistical analysis:**

The obtained data were analyzed statistically by one way Analysis of Variance (ANOVA) using SPSS statistical program (version-22). Significant difference between mean values was analyzed by Duncan’s Multiple Range Test (DMRT) at significance level of 0.05

1. **RESULT AND DISCUSSION:**

**3.13.1 Water quality parameters**

Monthly fluctuations in temperature, pH, dissolved oxygen, and transparency levels across the various experimental treatments are presented in the subsequent data (Table-1).

**Table 1: Variations in water quality parameters of FRP tanks under different treatments**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameters** | **Month** | **Treatments** | | | |
| Temperature | **T1(100/decimal)** | | **T2(150/decimal)** | **T3(200/decimal)** |
| April | 24.30±0.10a | | 24.65±0.10a | 24.75±0.10a |
| May | 27.40±0.10c | | 27.50±0.15bc | 27.65±0.15a |
| June | 31.60±0.14c | | 31.65±0.12bc | 31.75±0.10a |
| pH | April | 7.30±0.05a | | 7.30±0.10a | 7.15±0.15a |
| May | 8.20±0.15a | | 8.14±0.10a | 8.10±0.15a |
| June | 8.60±0.10a | | 8.55±0.10b | 8.65±0.15b |
| Dissolved Oxygen | April | 6.25±0.15a | 6.35±0.10b | | 6.50±0.15c |
| May | 7.00±0.10a | 7.55±0.10bc | | 7.00±0.15c |
| June | 7.45±0.10a | 7.20±0.15b | | 6.25±0.05c |
| Transparency | April | 26.30±0.05b | 26.45±0.10b | | 26.35±0.20a |
| May | 25.00±0.10b | 25.15±0.20a | | 25.35±0.10a |
| June | 28.40±0.10c | 28.65±0.10b | | 28.85±0.15a |

The study investigated the influence of varying stocking densities of *Mystuscavasius* on key water quality parameters within FRP tanks. Statistical analysis revealed a significant impact (P<0.05) of stocking density on temperature. Specifically, the highest mean temperature (31.75 ∘C) was observed in treatment T3 at the culmination of June, closely followed by T2 (31.65 ∘C), while the lowest temperature (31.60 ∘C) was recorded in T1. Notably, no significant thermal differences were detected across treatments during April and May.

Furthermore, significant variations (P<0.05) were evident in other water quality parameters. In June, the highest dissolved oxygen (DO) concentration (7.45 ppm) was measured in T1, and the lowest (6.25 ppm) in T3. Concurrently, pH values in June ranged from 8.60 in T1 to 8.65 in T3. Transparency levels in June were highest in T3 (28.85 cm) and lowest in T1 (28.40 cm). These findings suggest that stocking density of *Mystuscavasius* significantly modulates temperature, dissolved oxygen, pH, and transparency within the experimental tank environment, with the most pronounced differences observed towards the end of the experimental period.

A fundamental inverse relationship typically exists in aquatic systems, wherein elevated temperatures constrain the solubility of oxygen, leading to a reduction in dissolved oxygen (DO) concentrations. However, the findings of this study notably deviated from this established principle, demonstrating a counterintuitive trend of DO levels increasing in conjunction with temperature fluctuations throughout the experimental period. This observed positive correlation between temperature and dissolved oxygen warrants further investigation to investigated the underlying mechanisms driving this atypical pattern within the *Mystus cavasius* culture system under the tested conditions. The observation of lower dissolved oxygen (DO) levels with increasing stocking density aligns with findings from previous research. This outcome is consistent with the studies conducted by Oguguah *et al*. (2011) and Kohinoor *et al*. (2016), which similarly reported a negative correlation between fish stocking density and dissolved oxygen concentrations in aquaculture systems. This phenomenon is likely attributable to increased biological oxygen demand (BOD) resulting from higher fish biomass and metabolic activity in denser stocking conditions. The mean pH values across the different treatments exhibited a decreasing trend from T1 to T3, although the difference was not statistically significant (P>0.05). These observed pH values are consistent with the findings reported by Shahroz *et al*. (2019) and Rahman *et al*. (2021) in similar aquaculture contexts. It is plausible that increased stocking density contributes to a higher production of carbon dioxide (CO2​) due to enhanced respiration, which can subsequently lead to a reduction in both dissolved oxygen (DO) and pH levels. Conversely, the comparatively higher pH values recorded suggest a degree of productivity within the water column.Water transparency within the studied ponds exhibited seasonal variability. Furthermore, water quality parameters were generally more favorable in the treatment with the lowest stocking density (100 individuals per decimal) when compared to the treatments with higher stocking densities. This suggests that lower stocking densities are associated with improved water clarity and overall water quality within these FRP ecosystems.

* 1. **Growth parameters**
     1. **Total length**

The study investigated the influence of varying stocking densities on the total length of *Mystus cavasius*. The findings, presented in Figure 1, demonstrated a statistically significant (p < 0.05) effect of stocking density on the total length of the fish. Specifically, the greatest total length (18.02 cm) was observed in the treatment group with the lowest stocking density (T1), while the smallest total length (3.08 cm) was recorded in the treatment group with the highest stocking density (T3). Across all sampling periods, the trend of total length consistently decreased with increasing stocking density, with T1 exhibiting the highest values, followed by T2, and then T3.

**Fig 1: The changes of total length of *Mystus cavasius* in three different treatments**

* + 1. **Total weight**

This study (Fig.2) illustrates the sustained significant impact of stocking density on the final weight of *Mystuscavasius*. At the conclusion of the experimental period, the highest final weight, measuring 16.72 g, was recorded in the treatment group with the lowest stocking density (T1). Conversely, the lowest final weight, 11.67 g, was observed in the treatment group with the highest stocking density (T3), with the intermediate stocking density group (T2) exhibiting a final weight of 13.21 g.

**Fig 2: Effect of stocking density on weight of *Mystus cavasius* in three different treatments.**

* + 1. **Specific growth rate**

The specific growth rate (SGR) of *Mystus cavasius,* as illustrated in Figure 3, exhibited a range of values across the experimental treatments. Specifically, SGR varied from 3.23% to 1.06% in treatment group T1, 2.49% to 0.78% in T2, and 2.29% to 0.66% in T3. Notably, the SGR demonstrated a statistically significant inverse relationship with stocking density. The highest SGR was consistently observed in the lowest stocking density group (T1), followed by T2 and then T3, indicating that lower stocking densities promote a higher rate of specific growth in *Mystus cavasius*.

**Fig 3: The changes of specific growth rate of *Mystus cavasius* in three different treatments.**

* + 1. **Survival rate and Food conversion rate (FCR)**

The stocking density significantly influenced the survival rate of *Mystus cavasius,* as detailed in Table 2. Optimal growth and survival of aquatic organisms are intrinsically linked to appropriate stocking densities. Our findings indicate an adverse relationship between increased stocking density and survival rate. All FRP tanks were stocked with spawn of uniform initial length (5.73±0.02 cm) and weight (4.16±0.09 g). Average daily gain was highest in T1 (0.079±0.04), followed by T2 (0.052±0.04), and lowest in T3 (0.041±0.01).

Elevated stocking densities are known to deteriorate water quality, which, in turn, compromises the growth, disease resistance, and overall survival of cultured organisms (M’balaka*et al*., 2012). This study reinforces that maintaining an optimal stocking density is crucial for the successful rearing of *Mystuscavasius*.

The Feed Conversion Ratio (FCR) was significantly lower in treatment T1 (1.25±0.01) compared to T2 (1.62±0.01) and T3 (2.04±0.02). These findings indicate that the lowest stocking density (T1), where the fewest hatchlings were reared, resulted in the most favorable specific growth rate (SGR) and FCR.

The FCR values observed in this study are notably lower than those reported by Chakraborty (2022) and Islam (2002). As De Silva and Davy (1992) suggested, digestibility plays a crucial role in reducing FCR by enhancing the efficiency of food utilization. Digestibility, in turn, is influenced by factors such as daily feeding rate, feeding frequency, and the type of feed employed (Chiu *et al*., 1987). Consequently, the lower FCR values obtained in the current study signify a superior food utilization efficiency in the experimental subjects.

**Table 2: Survival and FCR of *Mystus cavasius* fry or fingerlings after twelve weeks of rearing.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Treatments** | | |
| **T1** | **T2** | **T3** |
| **Initial length (cm)** | 5.73±0.02 | 5.73±0.02 | 5.73±0.02 |
| **Final length (cm)** | 18.02±0.15 | 12.74±0.37 | 10.83±0.89 |
| **Initial weight (g)** | 4.16±0.09 | 4.16±0.09 | 4.16±0.09 |
| **Final weight (g)** | 16.72±0.45 | 13.21±0.82 | 11.67±0.71 |
| **Average daily gain(g)** | 0.079±0.04a | 0.052±0.04b | 0.041±0.01c |
| **Survival rate (%)** | 92.24% | 90.76% | 88.45% |
| **FCR** | 1.25±0.01a | 1.62±0.01b | 2.04±0.02c |

1. **CONCLUSION**

The present study indicates that for *Mystus cavasius* fingerlings, lower stocking densities of fry positively correlate with improved growth, survival rates, and overall production and benefits. Specifically, a stocking density of 100 individuals/m³ consistently yielded the highest performance across all parameters in controlled environments. Therefore, a stocking density of 100 individuals/m³ is recommended for the 12-week rearing of *M. cavasius* fingerlings in FRP tanks. Given the significant degradation of natural *M. cavasius* habitats due to environmental and anthropogenic factors, the successful application of these findings to produce healthy and high-quality fingerlings holds substantial implications. This approach could be crucial for preventing the extinction of this important catfish species, safeguarding its genetic diversity, and contributing to overall aquatic biodiversity. Further investigations are essential to identify even more optimized stocking densities and to develop large-scale seed production techniques for *M. cavasius* in captive nursery-rearing systems.

**Ethics approval and consent to participate:**

All the experimental techniques and fish care protocols used in the current study were followed by the Guidelines of the Committee constituted for the purpose (Ethical Approval Committee, EAC) at College of Fisheries, Assam Agricultural University with vide approval no. AAU/G-9/COF/2021-22/4104 Dated 23/04/2023.

**DISCLAIMER (ARTIFICIAL INTELLIGENE):**

Authors hereby declare that no generative AI technologies such as Large languge Models or text to image were used during the writing

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**COMPETING INTERESTS:**

The authors have no known competing financial interests or personal relationships that could have influence the work reported in this paper

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