



Original Research

Assessing the Stress Responses and Aquaculture Potential of Silver Barb (*Barbonymus gonionotus*) Under Saline Exposure

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Abstract

This study evaluated the salinity adaptation capability of silver barb (*Barbonymus gonionotus*) by examining its physiological and behavioral stress responses under varying saline conditions. In an acute toxicity bioassay using the direct transfer method, 180 fish were exposed to salinity levels ranging from 0 to 16 ppt for 72 hours. The species survived exposure up to 12 ppt, with a 72-hour median lethal salinity LC₅₀ of 14 ppt determined via probit analysis. Subsequent 72-hour evaluations of body weight dynamics, gill histology, and behavior were conducted across two sub-lethal salinities (8 ppt and 12 ppt) and two lethal salinities (14 ppt and 16 ppt). Fish exposed to sub-lethal concentrations (up to 12 ppt) displayed minimal behavioral distress, a gradual decline in body weight, and minor gill alterations restricted to lamellar rupture accompanied by light mucus secretion. Conversely, exposure to lethal salinities (14 ppt and 16 ppt) induced severe physiological and behavioral stress including rapid osmotic body weight loss, marked hyper-agitation, erratic swimming, and accelerated opercular movements. Histological analysis of gills from lethally exposed fish revealed extensive structural damage, including curved and broken filaments, severe lamellar rupture, and tissue necrosis. These findings demonstrate that while elevated salinity significantly disrupts the physiology and behavior of silver barb near lethal thresholds, the species possesses sufficient tolerance to make it a promising candidate for aquaculture in low-salinity brackish environments.

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Statement of Sustainability: This study highlights the potential of silver barb (*Barbonymus gonionotus*) for climate-resilient aquaculture in regions increasingly impacted by freshwater salinization and sea-level rise. Demonstrating a 72-hour LC₅₀ threshold of 14 ppt and sub-lethal tolerance up to 12 ppt, the species exhibits sufficient osmoregulatory capacity to support sustainable production in low-salinity brackish environments without severe physiological stress. Establishing these upper salinity limits provides essential baseline data for responsible stocking and fish welfare management, optimizing resource use in coastal waters while supporting local food security under changing climate conditions. This study aligns with SDG 13 (Climate Action) and SDG 2 (Zero Hunger) by identifying silver barb (*Barbonymus gonionotus*) as a climate-resilient candidate for brackish water aquaculture, while simultaneously supporting SDG 14 (Life Below Water) through the establishment of safe salinity boundaries to safeguard fish welfare.

1. Introduction

Global aquaculture is currently facing unprecedented challenges driven by climate change, rising sea levels, and the ongoing degradation of freshwater resources (Rashid and Mithun, 2020; Sazzad et al., 2024). Among these challenges, secondary salinization, the increasing concentration of dissolved salts in freshwater ecosystems, stands out as a critical threat to inland fisheries and aquaculture production (Mithun et al., 2024; Islam et al., 2025). In many developing regions, particularly across South and Southeast



Asia, extensive river deltas and low-lying agricultural zones are experiencing rapid salt intrusion due to tidal surges, reduced upstream freshwater discharge, and unsustainable groundwater extraction. Because the vast majority of global aquaculture relies on strictly freshwater fishes, this environmental shift directly threatens rural livelihoods, economic stability, and food security. The silver barb (*Barbonymus gonionotus*), alternatively known as the Java barb, is a premier candidate in Asian freshwater aquaculture. Renowned for its rapid growth cycle, ability to utilize low-cost organic feeds, and high market acceptability among low-to-middle-income consumers, it serves as a foundational species for polyculture systems (Lawson and Anetekhai, 2011; Sunny et al., 2025). Consequently, understanding how environmental stressors alter the biological performance of such highly valued freshwater species under captive conditions has become an ecological and economic imperative. Under normal physiological conditions, strictly freshwater fish like *B. gonionotus* are hyperosmotic to their surrounding environment (Uliano et al., 2010). This means their internal body fluids maintain a higher salt concentration than the external water, forcing them to continuously counteract the passive influx of water and loss of essential ions (Semra et al., 2013; Islam and Mithun, 2024). When exposed to elevated ambient salinity, this delicate homeostatic balance is severely disrupted (Deal and Volkoff, 2020; Sunny et al., 2025; Islam et al., 2025a).

The current state of scientific knowledge indicates that salinity stress triggers a cascade of physiological, behavioral, and metabolic alterations in stenohaline freshwater fish. Initial exposure typically induces acute osmotic shock, forcing the organism to redirect significant metabolic energy away from somatic growth and reproduction toward energetically demanding active ion transport mechanisms, primarily driven by branchial Na^+/K^+ -ATPase enzymes (Anni et al., 2016; Han et al., 2022). Prolonged or chronic salinity stress frequently leads to cellular dehydration, hematological abnormalities, compromised immune function, and elevated oxidative stress, which collectively manifest as reduced growth performance, erratic swimming behavior, and increased mortality rates (Cowan et al., 2017; Hayashi et al., 2021). While baseline salinity tolerances have been mapped for a few select cyprinids, the precise thresholds, tissue-specific damage, and recovery dynamics remain highly variable across different species (Canosa and Bertucci, 2023; Moniruzzaman et al., 2024).

Despite the growing body of literature detailing salinity tolerance in marine and euryhaline species, a profound research gap persists regarding the specific physiological limits and adaptive boundaries of *B. gonionotus* when subjected to distinct salinity regimes in captive environments (Costa et al., 2019). Most historic aquaculture data assume a static, low-salinity environment for this species, leaving its sub-lethal stress responses largely unquantified. Existing studies often look at sudden, lethal salinity end-points rather than the gradual, chronic exposures that mirror real-world deltaic conditions (Ferreira-Martins et al., 2023; Kobir et al., 2024; Alam et al., 2023). Furthermore, there is a distinct lack of comprehensive data integrating multi-level responses combining behavioral observation, growth metrics, and biochemical stress markers within a single, controlled experimental framework for the silver barb (Mousa et al., 2018; Ferdous et al., 2024; Alam et al., 2023a). It remains unclear at what precise parts per thousand (ppt) salinity threshold the silver barb transitions from efficient physiological compensation to metabolic exhaustion and systemic failure. Closing this knowledge gap is essential if farmers are to predict the viability of *B. gonionotus* stocks in areas increasingly prone to seasonal brackish water intrusion.

To address these critical uncertainties, this study was designed to systematically evaluate the biological consequences of salinity stress on the silver barb under controlled captive conditions. The primary objective of this research is to determine the definitive salinity tolerance thresholds of *B. gonionotus* by assessing its survival, growth performance, behavioral adaptations, and selected hematological or biochemical stress indices across a gradient of salinity concentrations.

2. Materials and Methods

2.1. Experimental Site

The study was conducted over a period of six months at the Freshwater Sub-station of the Bangladesh Fisheries Research Institute (BFRI), located in Saidpur, Nilphamari (25° 46' 41" N, 88° 53' 51" E) (Figure 1).

2.2. Collection and Rearing of Experimental Fish and Preparation of Test Solution

Healthy, moderately sized (8.45 ± 1.32 cm) silver barb were collected from the fish pond of BFRI and reared in a cemented rectangular tank. Silver barb with an average weight of 9.2 ± 1.37 g were selected and allowed to acclimatize to laboratory conditions at 24–26 °C for 15 days to remove suspected unhealthy subjects (handling and transportation stress). A total of 180 individuals were randomly assigned. They were housed in a large water tank containing tap water and provided with an aeration system. Fish were fed twice a day with commercial dry pellets. The fish were considered well adapted to laboratory conditions when mortality was recorded at less than 1% during the 15-day acclimatization period. Fish of both sexes were used without discrimination.

The saline water was prepared by adding an appropriate amount of salt (NaCl) to chlorinated tap water. A fixed ratio (g/L) was maintained to obtain the predetermined salinity level for each treatment. A 50 L aquarium containing 26 L of water was used for each treatment, and the required amount of salt, weighed in grams, was added to each aquarium. The solution was prepared using the following formula:

$$V_1 (S_3 - S_1) / S_2 - S_3$$



Here, V_2 =volume of required solution V_1 =volume of tap water; S_1 =salinity of tap water S_2 =salinity of mother tank S_3 =required salinity level.

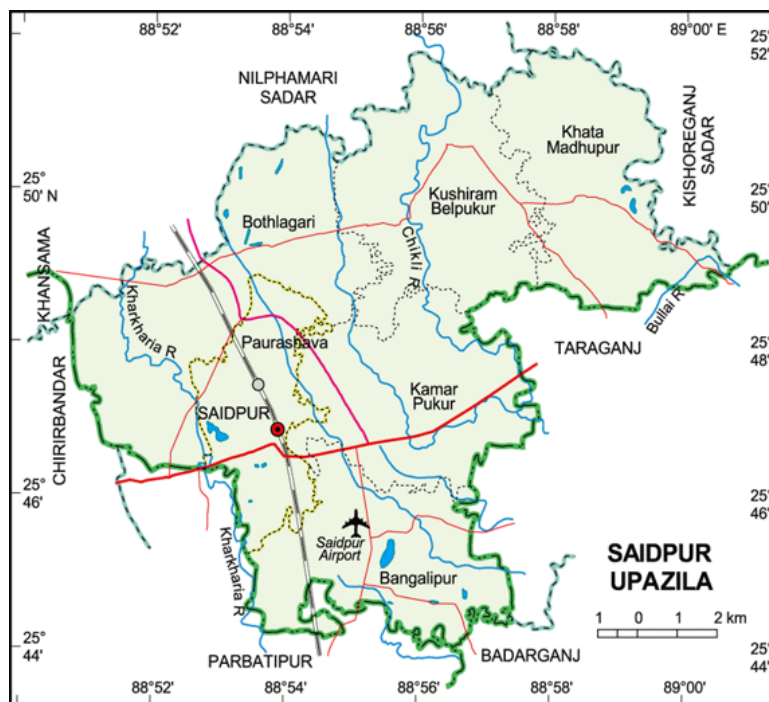


Figure 1. Map of experimental site.

2.3. Experimental Design

The experimental design followed a structured workflow to assess the physiological and behavioral responses of fish to varying salinity levels. Initially, fish were subjected to a 72-hour range-finding test across different salinity concentrations, after which the 72-hour median lethal concentration (12 ppt) was determined via probit analysis (Figure 2). The experimental framework was then split into two primary tracks: lethal effects (salinity levels exceeding the) and sub-lethal effects (salinity levels below the). These tracks evaluated three core parameters: behavioral stress, osmotic balance, and blood physiological parameters. For the behavioral study over 96 hours, fish were assigned to control (T1), sub-lethal (T2, T3), and lethal (T4, T5) salinity exposures to monitor stress responses. For osmotic balance, fish were exposed to identical control (T1), sub-lethal (T2, T3), and lethal (T4, T5) treatments over a 72-hour period to observe variations in body weight and morphological alterations in the gills. For blood parameter analysis, fish were exposed to control conditions (T1) and treatments set at 50% of the value for 72 hours to evaluate blood glucose concentration levels. All collected observational and physiological data were subsequently subjected to statistical analysis to evaluate treatment effects.

2.4. Acute Toxicity Assay and Determination

Range-finding bioassays were performed in accordance with standard aquatic toxicity protocols (APHA, 1975; Reish & Oshida, 1987). Ten randomly selected fish per treatment group were exposed directly to salinity levels of 0 (control, T1), 8 (T2), 12 (T3), 14 (T4), and 16 (T5) ppt for 72 h under static bioassay conditions with continuous aeration.

Fish were inspected regularly, and mortalities defined by cessation of opercular movement and lack of reaction to mechanical stimuli were immediately removed. Median lethal concentration values (and) were calculated using Probit Analysis based on 72 h mortality data. Concentrations below were classified as sub-lethal, while concentrations above were designated as lethal.

2.5. Behavioral Stress Responses, Osmotic Balance and Weight Variation

Behavioral alterations were evaluated following exposure to control (0 ppt, T1), sub-lethal (T2, T3), and lethal (T4, T5) salinity concentrations over 72 h. Visual inspections were conducted at 0, 6, 12, 18, 24, 36, 48, 60, and 72 h. Key parameters recorded included convulsions, loss of equilibrium, fin movement rate, hyperactivity, swimming velocity, shoaling tendency, and changes in body/eye pigmentation. Behavioral stress severity was scored on an ordinal scale ranging from 0 (normal/no stress) to 5 (severe/very strong response) according to established guidelines (Aysel et al., 2010). To evaluate osmoregulatory impact, fish body weights were recorded under control (T1), sub-lethal (T2, T3), and lethal (T4, T5) salinity exposures at designated intervals (0, 6, 12, 24, 36, 48,



60, and 72 h). Weight tracking for a given treatment continued until cumulative mortality reached 50%.

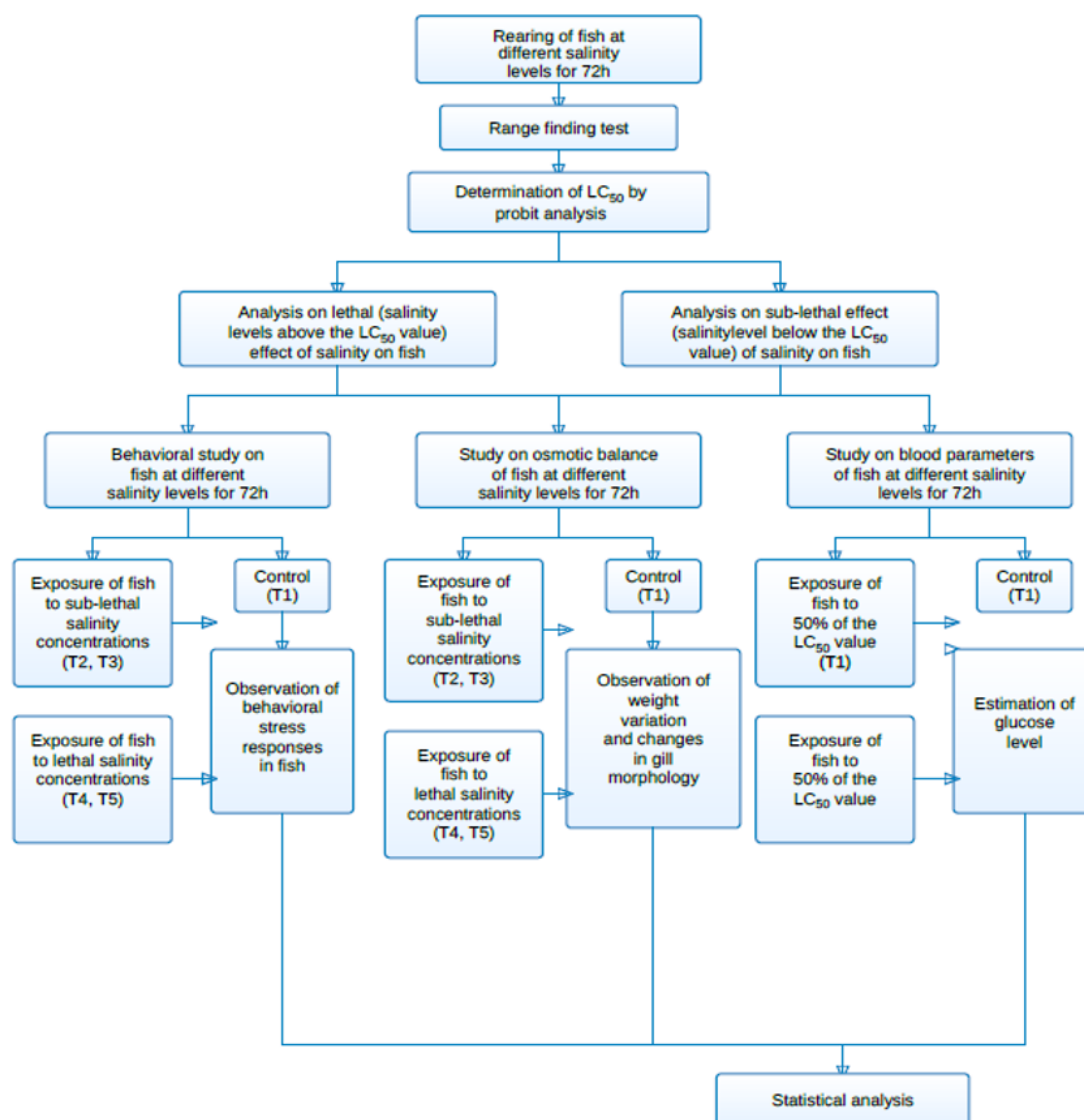


Figure 2. Flow diagram of the experimental design.

2.6. Blood Glucose estimation and Gill Morphological Examination

To measure physiological stress, fish were exposed to two sub-lethal salinity levels 50% (T1) and 75% (T2) of the calculated 72 h with three replications per treatment. Three fish per replicate were sampled at 3, 8, 12, 24, 48, and 72 h post-exposure.

Blood was collected via caudal vein puncture using micro-pipettes without prior anesthesia to prevent chemical stress artifacts. The entire sampling process was completed within 60 seconds per fish. Blood glucose levels (mmol/l) were immediately measured using a calibrated digital blood glucose meter (GlucoLeader).

Gills were excised from control, sub-lethal, and lethal treatment groups at 3, 8, 12, 24, 48, and 72 h post-exposure. Excised gill tissues were gently cleaned of blood, mucus, and debris using a soft brush, mounted on glass slides, and examined under a light microscope to observe structural changes.

2.7. Statistical Analysis

Data were analyzed using IBM SPSS Statistics (Version 16.0). Differences among treatment means were evaluated using one-way Analysis of Variance (ANOVA). Statistical significance was accepted at . Results are expressed as mean standard error (SE).



3. Results

Salinity is an important factor in determining many aspects of the chemistry of natural waters and of the biological processes within them. Although salinity concentrations in freshwater sources are almost zero, unwanted introduction of salinity may occur and can affect the normal physiological homeostasis of freshwater species. A range-finding test was conducted to evaluate the salinity tolerance of silver barb (*Barbonymus gonionotus*) across a concentration range of 0 to 16 ppt over a 72-hour exposure period (Figure 3). No mortality was observed at salinity levels up to 12 ppt; however, mortality increased sharply beyond this threshold, reaching 90% at 14 ppt and 100% at 16 ppt. Consequently, the median lethal salinity concentration (LC₅₀) for silver barb was narrowed down to between 12 ppt and 14 ppt.

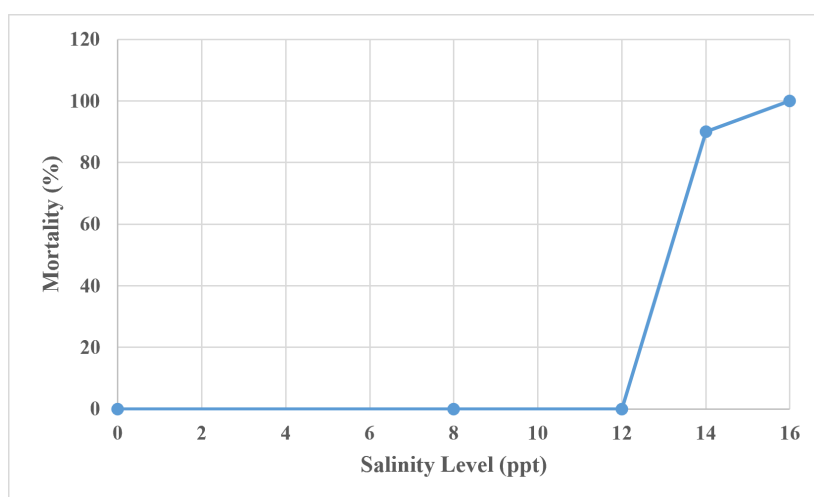


Figure 3. The test for the range finding of silver barb, exposed to different salinity showing percentage of mortality at different salinity levels after exposure of 96 hours.

3.1. Median Concentration (LC₅₀)

The median lethal concentration of salinity was determined at salinity levels ranging from 12 ppt to 16 ppt. No mortality was observed up to a concentration of 12 ppt during the 72 h exposure period. 100% mortality occurred at 16 ppt (Table 1). Probit analysis was performed on the number of dead fish observed after 72 h of exposure at different salinity levels. Probit analysis showed that the median lethal concentration, that is, the concentration causing 90% mortality of the fish, was about 14 ppt (Table 2).

Table 1. Mortality percentage of selected fish individuals exposed to different concentrations of salinity at different time intervals.

Concentration (ppt)	Initial Count of fish	Exposure time (hour)								Mortality (%)
		6	12	18	24	36	48	60	72	
0.00	10	0	0	0	0	0	0	0	0	00
8.00	10	0	0	0	0	0	0	0	0	00
12.00	10	0	0	0	0	0	0	0	0	00
14.00*	10	0	0	0	2	2	1	3	1	90
16.00	10	8	2	0	0	0	0	0	0	100

Here, 14 ppt was found to be the median lethal concentration value from the range-finding test. Thus, 8 ppt and 12 ppt were considered sub-lethal concentrations, whereas 14 ppt and 16 ppt were considered lethal salinity concentrations.

3.2. Lethal and Sub-lethal Effect of Salinity on Behavioral Stress Responses in Silver Barb

Effects of sub-lethal and lethal concentrations of salinity on behavioral stress responses in silver barb were observed. The fish exhibited normal behavioral activity without mortality when exposed to 0 ppt (control). At the sub-lethal salinity concentration (12 ppt), low stress responses were noticed, such as normal swimming, shoaling, FSBM, jumping, aggression and scattering. Stress responses such as death and abnormal body and eye color were observed at lethal concentrations (14 ppt and 16 ppt) (Tables 3, 4, and 5). At the beginning of the experiment (up to 3 hours), the fish showed frequent movement from surface to bottom, then aggression, and sometimes jumping activity, at the lethal concentrations of salinity. They also exhibited greatly increased opercular



movements accompanied by excessive secretion of mucus, which indicated respiratory distress. The fish were scattered here and there. They then became very weak, with faded and dull body and eye color, settled at the bottom and finally died (Figure 4).

Table 2. Lethal concentration of salinity at 72 h in silver barb.

Probability	95% Confidence Limits for Concentration			95% Confidence Limits for Log (Concentration) ^a		
	Estimate	Lower bound	Upper bound	Estimate	Lower bound	Upper bound
0.1	12.924	11.400	13.319	1.111	1.057	1.124
0.2	13.151	12.040	13.515	1.119	1.081	1.131
0.3	13.318	12.489	13.696	1.124	1.097	1.137
0.4	13.462	12.840	13.902	1.129	1.109	1.143
0.5*	13.598	13.116	14.163	1.133	1.118	1.151
0.6	13.735	13.332	14.500	1.138	1.125	1.161
0.7	13.884	13.510	14.933	1.143	1.131	1.174
0.8	14.060	13.675	15.508	1.148	1.136	1.191
0.9	14.307	13.867	16.389	1.156	1.142	1.215
0.95	14.515	14.010	17.176	1.162	1.146	1.235
0.99	14.992	14.263	18.782	1.174	1.154	1.274

a= log₁₀, * equal to median lethal concentration (LC₅₀).

Table 3. Agitated behavior after 72 hours of exposure.

Clinical signs	Salinity (ppt)				
	0	8	12	14	16
Aggression	0	1	2	3	5
Jumping	0	1	2	3	4
FSBM	0	0	1	2	4
Erratic swimming	0	0	2	3	3

Frequent surface to bottom movement (FSBM); none (0), very weak (1), weak (2), moderate (3), strong (4), very strong (5).

Table 4. Respiratory distress after 72 hours of exposure.

Clinical signs	Salinity (ppt)				
	0	8	12	14	16
Opercula movement	0	0	1	2	4
Air gulping	0	0	1	3	4
VPES	0	0	0	3	5
EMS	0	0	0	3	5

Vertical posture with exposed snouts (VPES), excessive mucus secretion (EMS); none (0), very weak (1), weak (2), moderate (3), strong (4), very strong (5).

Table 5. Abnormal nervous behavior after 72 hours of exposure.

Clinical signs	Salinity (ppt)				
	0	8	12	14	16
SSM	0	1	1	2	5
Motion	1	2	4	4	5
Sudden darts	0	0	2	3	4
DP	0	0	2	4	3
Death	0	0	0	4	5

Sluggish and swirling movements (SSM), different posture (DP), none (0), very weak (1), weak (2), moderate (3), strong (4), very strong (5).

3.3. Effects of Salinity on Blood Glucose

The silver barb selected for the present study showed variations in blood glucose level when exposed to 14 ppt and 16 ppt at different time intervals. Glucose levels in both treatments were found to increase within an hour and were highest at about 8–12 h. Glucose levels then gradually decreased and returned to their original state within 24 h (Figure 5).

3.4. Weight Variation of Fish Due to Salinity Treatment

In this study, the lethal and sub-lethal effects of salinity on osmotic balance were determined by observing variation in the weight of fish exposed to different salinity concentrations. Variation in weight due to the different lethal and sub-lethal salinity treatments

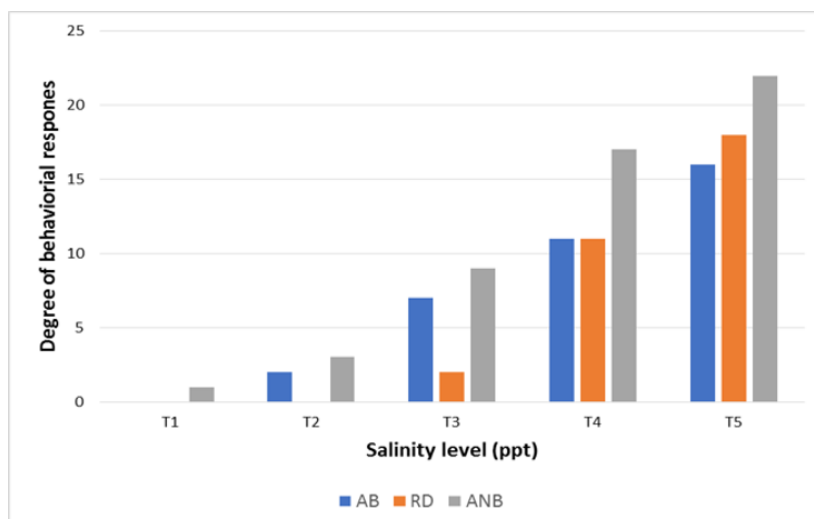


Figure 4. Degree of behavioral stress responses of fish at different salinity levels (AB= Agitated behavior, RD= Respiratory distress and ANB= Abnormal nervous behavior; T1= 0 ppt, T2= 8 ppt, T3= 12 ppt, T4= 14 ppt, T5= 16 ppt).

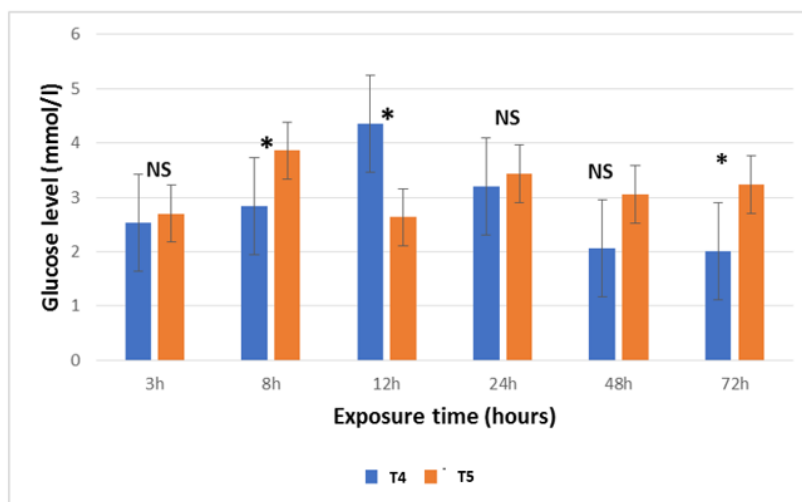


Figure 5. Sub-lethal effects of salinity on blood glucose levels (means±SD) at different time intervals in silver barb; * Indicates significant difference at $P<0.05$ (T4=14 ppt, T5=16 ppt).

is shown in Figure 6. Reduction in fish weight was observed for all the concentrations (0 ppt, 8 ppt, 12 ppt, 14 ppt and 16 ppt) at 6 hours after exposure to salinity treatments. From 6 h to 36 h, a gradual increase in weight was observed at all the concentrations; however, T3 (12 ppt) showed a sharp increase in weight. After 36 hours, T1 (0 ppt), T2 (8 ppt), T3 (12 ppt) and T4 (14 ppt) showed both increases and decreases in weight at different hours; however, T5 (16 ppt) showed a sharp decrease in fish weight.

3.5. Morphological Changes of Gill due to Salinity Rreatment

In the present study, morphological changes in the gills of salinity-treated fish were evaluated. Because gill lamellae serve as the primary site for water exchange and ionic flux, they are particularly susceptible to disruptions in osmotic balance. At the sub-lethal salinity concentration of 12 ppt, no significant alterations in overall gill morphology were observed, with the exception of occasional ruptured lamellae accompanied by slight mucus secretion. However, exposure to the lethal concentration of 14 ppt (T4) induced severe histological and structural changes compared to the control group (T1). Key pathological manifestations included extensive rupture and fragmentation of the secondary lamellae, as well as severe curvature and breakage of the primary gill filaments (Figure 7).

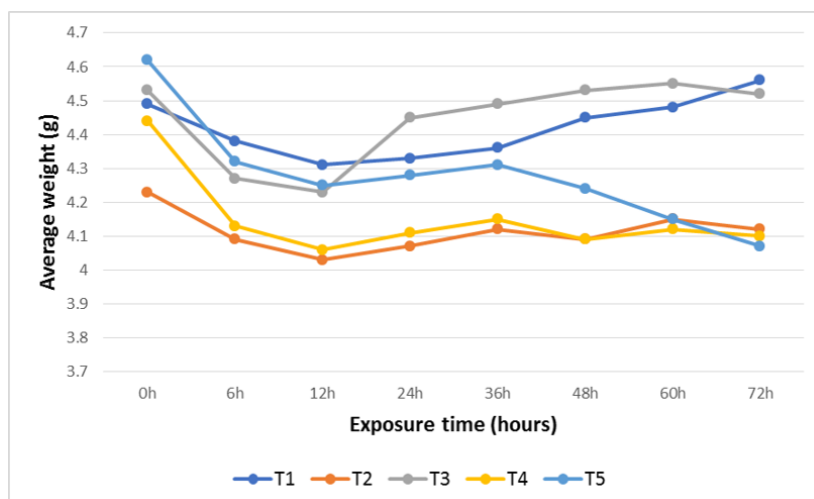


Figure 6. Fluctuation in average weight of fishes after exposure to sub-lethal and lethal salinity concentrations (T1= 0 ppt, T2= 8 ppt, T3= 12 ppt, T4= 14 ppt, T5= 16 ppt).

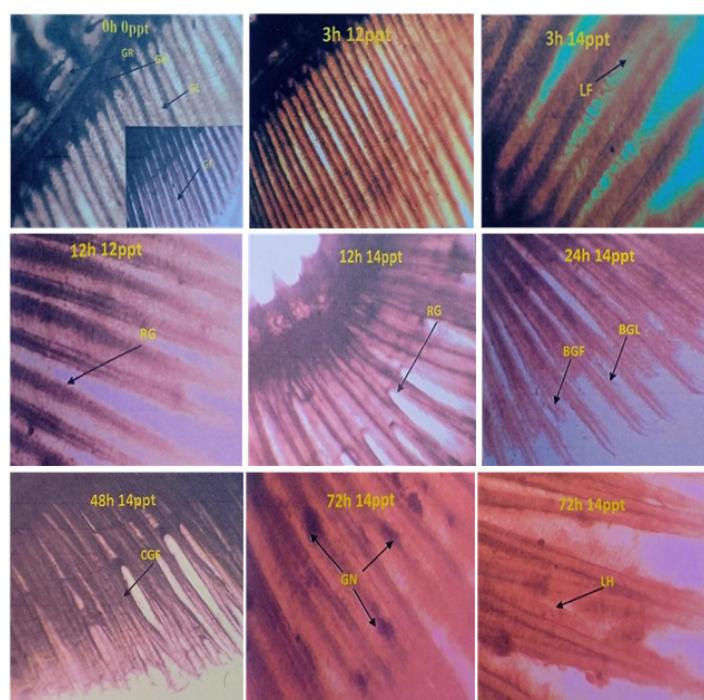


Figure 7. Microscopic view of gill morphology at different salinity levels at different time intervals (0, 3, 12, 24, 48 and 72h); Arrows indicate gill lamellae (GL), gill raker (GR), gill arch (GA), gill filament (GF), ruptured gill (RG), lamellar fusion (LF), broken gill lamellae (BGL), broken gill filament (BGF), curved gill filament (CGF), gill necrosis (GN) and lamellar hyperplasia (LH).

4. Discussion

The current findings demonstrate that silver barb can withstand salinity levels up to 12 ppt without experiencing mortality, aligning with the observations of Faunal and Christumus (2013). However, exposure to 16 ppt resulted in total mortality, with probit analysis yielding an LC_{50} threshold of 14 ppt. This places the species' upper tolerance above that of several other primary cyprinids. For instance, Banco and Nordlie (2008) reported an upper threshold of approximately 11 ppt for major cyprinids. Similarly, Kasım (1983) and Das et al. (2023) recorded lower initial lethal salinities for *Cirrhinus mrigala* (3.54 ppt), *Labeo fimbriatus* (7.07 ppt), and *Cyprinus carpio* (8.13 ppt), while Nazneen and Begum (1981) observed a maximum tolerance of 8.4 ppt in Ruby Barb (*Pethia padamya*).



Additionally, Maceina and Shireman (1979) found that acclimated fish exposed to 8 ppt suffered 80% mortality at 16.2 ppt, with a 24-hour median tolerance of 15.7 ppt. Carp fry also exhibit lower tolerance, with Garcia et al. (1999) reporting median lethal salinities of 2.3 ppt and 6.0 ppt for 11-day and 18-day-old *Aristichthys nobilis*, respectively. Sub-lethal salinity (12 ppt) induced minimal behavioral distress in silver barb, whereas lethal concentrations (14 ppt and 16 ppt) triggered severe agitation and erratic movements. During the initial 3 hours of lethal exposure, fish exhibited rapid vertical displacement between the surface and bottom, heightened aggression, occasional jumping, elevated opercular movement, and excessive mucus secretion, all contributing to respiratory distress. These behavioral manifestations are consistent with stress responses observed in fish subjected to elevated salinities by Lawson and Anetekhai (2011) and Aysel and Ayhan (2010). Reduced survival at elevated salinities is characteristic of freshwater stenohaline teleosts, driven primarily by increasing osmotic pressure (Kalambi and Zdinak, 1980). In this study, osmotic disruption manifested as fluctuations in body weight and structural alterations in gill tissue. At sub-lethal salinity (12 ppt), fish experienced an initial weight loss during the first 1–3 hours followed by a gradual recovery. Conversely, lethal concentrations (14 ppt and 16 ppt) induced rapid immediate weight loss, after which weights increased progressively over time, a pattern also reported by Augley (2008) and Maceina and Shireman (1979). Histological examination of gills revealed minimal damage at 12 ppt, restricted primarily to minor lamellar rupture and light mucus secretion. At 14 ppt, however, severe pathological alterations occurred, including broken and curved filaments, lamellar rupture, and tissue necrosis. Similar saline-induced gill lesions have been documented by Lin et al. (2004), Sardella et al. (2004), Yahona and Pablo (2007), and Evans et al. (2005). Hematological variables provide vital diagnostic indices for monitoring pathological and physiological adaptations in fish subjected to environmental stressors (Chakma et al., 2022; Kori-Siakpere et al., 2005; Cataldi et al., 1995; Atamanalp et al., 2002). Blood profiles readily reflect homeostatic disturbances and tissue-level toxicological impacts caused by exogenous factors (Bani and Vayghan, 2011). In this study, elevated salinity acted as a primary stressor disrupting glucose homeostasis. Under acute stress, chromaffin cells release catecholamines (adrenaline and noradrenaline) into circulation (Reid et al., 1998), acting synergistically with cortisol to stimulate glycogenolysis and glucose synthesis pathways to satisfy the energetic demands of the fight-or-flight response (Iwatani et al., 1999; Lucas, 1996). The accompanying hyper-glycemic response facilitates increased lactate transport from the liver to skeletal muscle to support rapid swimming movements (Ravichandran et al., 1995). Secondary stress responses involve shifts in blood biochemical parameters indicating either homeostatic disruption (e.g., electrolyte depletion) or compensatory physiological adjustments (e.g., elevated blood glucose), as described by Schreck (1990). Fish exposed to 50% and 75% of the LC₅₀ exhibited significant glucose elevations between 6 and 12 hours, likely driven by an initial catecholamine surge. By 12 hours, blood glucose levels began declining (measured at 24, 48, and 72 hours), suggesting that surviving individuals had initiated physiological acclimation to the hyper-saline medium. Although extreme salinity shifts induce acute physiological stress, silver barb exhibits sufficient osmoregulatory flexibility within a defined threshold. Given the expansion of oligohaline environments caused by sea-level rise and coastal inundation, silver barb represents a viable candidate species for culture in low-salinity brackish water systems.

5. Conclusion

Global climate change and sea-level rise threaten coastal freshwater aquaculture in Bangladesh through inland salinization. This study establishes that the silver barb (*Barbonymus gonionotus*) possesses effective osmoregulatory flexibility in oligohaline environments, tolerating salinities up to 12 ppt with minimal behavioral distress and temporary, recoverable weight loss. Physiological compensation was further evidenced by dynamic blood glucose mobilization at sub-lethal levels. However, the median lethal concentration was identified at 14 ppt, while 16 ppt induced severe neuromuscular and respiratory distress, rapid weight loss, and 100% mortality. Overall, *B. gonionotus* is a viable candidate for coastal aquaculture expansion within its 12 ppt physiological thresholds. Future research should investigate the saline adaptability of other commercial species, methods to enhance osmotic stress tolerance, and ecosystem-based adaptation strategies for higher-salinity production systems to support coastal food security under changing climate conditions.

Author Contributions

Conceptualization and Data curation: Srebash Kumar Saha, Sujan Mahmud, Mahmudul Hasan Mithun; Funding acquisition and Investigation: Azhar Ali, Maliha Hossain Mou; Methodology, Srebash Kumar Saha, Sujan Mahmud, A.K.M Rohul Amin; Resources: Azhar Ali; Software: Mahmudul Hasan Mithun; Supervision and Validation: Azhar Ali and A.K.M Rohul Amin; Visualization: Mahmudul Hasan Mithun; Writing – original draft: Sujan Mahmud, Mahmudul Hasan Mithun; Writing – review & editing: Sujan Mahmud, Mahmudul Hasan Mithun, Srebash Kumar Saha.

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Declarations

Conflicts of Interest: The authors declare no conflict of interest.

Institutional/Ethical Approval: Ethical Approval for this study was obtained from Bangladesh Fisheries Research Institute authority (Code No BFRI/FS/15).

Data Availability/Sharing: The datasets used and analyzed during the current study will be made available by the corresponding author upon reasonable request.

Supplementary Information Availability: Not applicable.

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