International Journal of Global Science Research **ISSN: 2348-8344 (Online)**
Vol. 13, Issue. 1, April 2026, pp. 9030-9034 **DOI: https://doi.org/10.26540/ijgsr.v13.i1.2026.342**
***Available Online* at www.ijgsr.com**

Research Paper

Comparative study of water quality parameters in different aquarium within a fish laboratory

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Received: 25/03/2026
Revised: 31/03/2026
Accepted: 10/04/2026

Abstract: The present study evaluates the physico-chemical characteristics of water in five experimental aquariums maintained under laboratory conditions from April to June 2025. Key parameters such as temperature, pH, ammonia, nitrate, hardness, alkalinity, chloride, fluoride, iron, and free chlorine were analyzed at weekly intervals. Significant variations were observed among tanks due to differences in stocking density, aquatic vegetation, and tank design. Tanks with aquatic plants showed better stability and lower nutrient accumulation. The findings emphasize the importance of proper aquarium management for sustainable ornamental fish culture.

Keywords: Water quality, Aquarium, Ammonia, Nitrate, Ornamental fish, Aquatic vegetation

Introduction:

Water quality is a critical factor influencing fish health and productivity in aquaculture systems. In closed systems like aquariums, rapid accumulation of metabolic waste can lead to deterioration of water conditions (Boyd and Tucker, 2012; Francis-Floyd, 2009). Therefore, comparative evaluation of water parameters across tanks is essential for improving management practices. Parameters such as temperature, pH, and dissolved oxygen directly influence metabolic activities, while ammonia and nitrate accumulation can cause physiological stress and mortality (El-Sayed, 2020; Bhatnagar and Devi, 2013). This study focuses on understanding how different aquarium setups influence water quality dynamics and fish sustainability under laboratory conditions.

Materials and Methods:

The experiment was conducted in a controlled fish laboratory using five aquariums with varying sizes, stocking densities, and ecological setups. Standard methods were followed for monitoring water quality parameters at weekly intervals to ensure accuracy and consistency in observations, as recommended in aquaculture water quality protocols (APHA, 2017; Boyd, 2015).

Experimental Setup

The study was conducted in five aquariums (Tank-1 to Tank-5) under controlled environmental conditions to minimize external variations and maintain consistency throughout the experimental period.

Table 1: Tank Specifications

Tank	Length (cm)	Width (cm)	Height (cm)	Capacity (L)	Type
T1	88	29	30	85	Breeding
T2	73	29	37	75	Community
T3	44	29	36	45	Carp
T4	44	29	36	45	Community
T5	46	29	38	50	Carp

The variation in tank size influences carrying capacity and water stability, as smaller tanks are more prone to fluctuations (Colt, 2006).

Table 2: Stocking Details

Tank	Species	Number
T1	Molly	7
T2	Swordtail	5
T3	Zebra danio + Blue danio	20
T4	Puntius + Barilius	11
T5	Goldfish + Pleco	5

Stocking density directly affects water quality, particularly ammonia and nitrate accumulation due to metabolic waste (Rahman et al., 2017).

Observations:

Water quality parameters were recorded at regular intervals from April to June 2025. Observations revealed noticeable variation among tanks depending on their biological load and environmental setup. Tanks with plants and moderate stocking showed more stable conditions compared to heavily stocked tanks.

Table 3: Date-wise Sample Observation

Date	Tank	Temp (°C)	pH	Ammonia (mg/L)	Nitrate (mg/L)	Hardness (mg/L)
24/04/25	T1	25	7.8	0.3	10	500
24/04/25	T2	29	8.0	0.3	10	300
09/05/25	T3	20	8.0	0.2	0.5	250
17/05/25	T4	27	8.0	0.2	10	250
24/06/25	T5	29	8.0	0.3	0.1	250

This table represents selected observations showing variation in temperature, ammonia, and nitrate levels across different tanks and dates.

Table 4: Monthly Average Observation

Tank	Temp (°C)	pH	Ammonia (mg/L)	Nitrate (mg/L)
T1	25–27	7.8–8.1	0.1–0.2	0.5–10
T2	27–29	7.8–8.0	0.1–0.3	0.5–10
T3	20–31	7.5–8.2	0.1–0.2	0.5–0.9
T4	27–29	7.9–8.1	0.2–0.5	0.8–10
T5	24–29	7.9–8.5	0.1–0.3	0.1–10

Monthly averages indicate that Tanks 2 and 4 showed higher nitrate accumulation, while Tank-3 showed greater temperature fluctuation.

Results:

The results indicated significant variation in water quality parameters among the five tanks. Differences in tank design, stocking density, and presence of aquatic plants influenced the overall water quality and stability. Similar variations have been reported in controlled aquaculture systems where management practices differ among tanks (Hossain et al., 2018).

Table 5: Overall Range of Water Quality Parameters

Parameter	Range Observed
Temperature (°C)	20 – 31
pH	7.5 – 8.5
Ammonia (mg/L)	0.0 – 0.5
Nitrate (mg/L)	0.1 – 20
Hardness (mg/L)	200 – 500
Alkalinity (mg/L)	600 – 900
Chloride (mg/L)	40 – 140
Fluoride (mg/L)	0.1 – 1.5
Iron (mg/L)	0.0 – 0.2
Free Chlorine (mg/L)	0.0 – 0.6

Most parameters remained within acceptable limits for freshwater fish culture, although ammonia and nitrate occasionally exceeded safe levels, which may stress fish (El-Sayed, 2020).

Table 6: Mean ± SD of Key Parameters

Tank	Temp (°C)	pH	Ammonia (mg/L)	Nitrate (mg/L)
T1	25.7 ± 2.4	7.9 ± 0.2	0.11 ± 0.07	2.5 ± 3.2
T2	27.9 ± 2.5	8.0 ± 0.1	0.22 ± 0.09	7.6 ± 4.2
T3	26.1 ± 3.1	8.0 ± 0.2	0.15 ± 0.08	2.4 ± 2.8
T4	27.2 ± 2.6	8.0 ± 0.1	0.24 ± 0.11	6.5 ± 3.9
T5	27.0 ± 2.3	8.16 ± 0.25	0.22 ± 0.10	5.8 ± 3.5

The statistical analysis indicates that tanks with vegetation and moderate stocking (T1) maintained better stability, while tanks with higher biomass showed increased variability (Bhatnagar and Devi, 2013). The observed ranges indicate that most parameters remained within acceptable limits, although occasional spikes were recorded in ammonia and nitrate levels.

Table 6: Mean ± SD of Key Parameters

Tank	Temp (°C)	pH	Ammonia (mg/L)	Nitrate (mg/L)
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T4	27.2 ± 2.6	8.0 ± 0.1	0.24 ± 0.11	6.5 ± 3.9
T5	27.0 ± 2.3	8.16 ± 0.25	0.22 ± 0.10	5.8 ± 3.5

The statistical analysis shows that Tank-1 was the most stable, whereas Tanks-2 and 4 exhibited higher nutrient accumulation.

Discussion:

The findings clearly demonstrate that aquarium design and biological factors significantly affect water quality. Tanks with aquatic vegetation maintained better ammonia control and pH stability due to natural filtration processes, supporting previous findings that aquatic plants act as biofilters (Boyd, 2015). In contrast, tanks with higher biomass showed increased nutrient accumulation, leading to fluctuations in ammonia and nitrate levels (Rahman et al., 2017).

Temperature variation was highest in smaller tanks, indicating reduced thermal stability, which is consistent with findings by Colt (2006). High alkalinity levels helped maintain pH stability but may contribute to stress when excessively high. The observed ammonia levels above 0.25 mg/L in some tanks indicate potential toxicity risks, as reported by Francis-Floyd (2009). Overall, the results align with previous studies emphasizing the importance of stocking density, tank design, and biological filtration in maintaining water quality.

Conclusion:

The study concludes that water quality in aquariums is strongly influenced by tank size, stocking density, and presence of aquatic vegetation. Tanks with balanced ecological setups showed better stability and fish health. Proper management practices are essential for sustainable aquarium systems.

Recommendations:

Maintaining optimal water quality requires careful monitoring and management. Moderate stocking, inclusion of aquatic plants, regular water exchange, and controlled feeding are essential for maintaining healthy aquarium conditions. Implementation of these practices will improve fish survival and productivity.

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