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Effect of novel diets on the physico-chemical characteristics of water in ornamental fishes of *Poecilia reticulata* W. Peters and *Pethia conchonius* F. Hamilton

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Abstract

Water quality is characterized by the chemical, physical and biological composition of the environment. Life in aquatic environments is predominantly influenced by the physico-chemical properties and their consistency. The effects of various novel diets on the physicochemical characteristics of water in ornamental fish species *Poecilia reticulata* and *Pethia conchonius* were subjected with various treatment intervals. The *in vitro* tank water samples were obtained from 12 glass fish tanks at different intervals with the physical and chemical parameters of the environment were analyzed with promptly upon arrival at the laboratory. The physicochemical factors that contribute to optimize fish growth in aquatic environments encompass of pH, temperature, ammonia, electrical conductivity, dissolved oxygen, total alkalinity, turbidity, total dissolved solids and total hardness were analysed. In contrast, the chemical parameters such as Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) serve as indicated the pollution levels present in a specific water body. The Guppies (*Poecilia reticulata*) and Rosy barbs (*Pethia conchonius*) was assessed by providing five different types of formulated diets comprised the probiotics (T1), *Spirulina* (T2), synthesized zinc oxide nanoparticle from *Spirulina* (T3), *Cynodon dactylon* (T4), synthesized zinc oxide nanoparticle from *C. dactylon* (T5), combination feed (T1+T2+T3+T4+T5) (T6) and the result was compared with the supplied commercial diet as a control also maintained. However, the novel diets of fish fed was suitable candidature for ornamental fish industry.

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Introduction

Guppy breeders are facing significant pressure to enhance the quality of their guppy fish in response to the strong demand in the global market. Water quality is identified as a crucial element influencing the success or failure of fish farming operations. These organisms inhabit a wide range of environments from murky waters in ponds, canals and ditches located at lower altitudes to clear mountain streams situated at higher elevations. Guppies are small freshwater fish that originate from Trinidad and the North Coast of South America. Their wide caudal fin displays contrasting colors with various patterns and the striking red color is particularly eye-catching (Kent and Ojanguren, 2015). Guppy fish have a very economical selling price compared to other freshwater ornamental fish (Nugroho *et al.*, 2021).

Additionally, the environments with limited water exchange, there exists a risk of elevated nutrient levels which can lead to water eutrophication and may adversely affect fish health by reducing the dissolved oxygen levels. Research indicated that the mortality rate of rainbow trout can begin when the dissolved oxygen concentration (Sonila *et al.*, 2015).The temperature of water and its fluctuations play a crucial role in shaping the composition of biological communities, as it influences the metabolic requirements of individual organisms (Sangeeta and Surjya, 2023). The rise in metabolic demands is not compensated by enhanced food availability or methods to optimize energy intake, it is probable that populations of experience a decline or face extinction (Gorman *et al.*, 2016). Changes in temperature significantly influence the levels of dissolved oxygen in aquatic environments. As temperature increases, the concentration of dissolved oxygen (DO) in water diminishes. Low levels of DO negatively impact fish growth, feed efficiency and the natural immune response of the body (Abdel-Tawwab *et al.,* 2015).

The rosy barb, generally referred to as *Pethia conchonius* a small, well-linked freshwater cyprinid that is indigenous to India and other regions of Southeast Asia. *P. conchonius* is a species that is highly regarded by aquarium enthusiasts due to its resilience, rendering it a favored option for decorative fish in residential aquariums (Cogliati *et al.*, 2010). However, numerous aspiring fish farmers, gaining fundamental knowledge regarding pond fish rearing, encounter challenges in maintaining optimal water quality in their ponds. It is evident that various water quality parameters exist within pond fish culture. Fortunately, only a limited number of these parameters are critical. These are the factors that fish farmers should focus on and strive to manage through appropriate techniques (Kasim, 2017). Additionally, substrate enrichment such as the use of sand or gravel is frequently observed in home aquaria and has been shown to enhance foraging behavior in goldfish (Carbia and Brown, 2019).

The physico-chemical properties of water are essential in influencing both the life history and distribution of fish species. A notable deficiency in research concerning the appropriate range of water quality parameters that support the survival of small freshwater fish as well as the impact of these physico-chemical parameters on their assemblages (Vanderzwalmen *et al.,* 2022). The physico-chemical characteristics of aquatic environments primarily influence the biology and physiology of the fish species that inhabit them. The diversity of finfish is directly impacted by factors such as mortality rates, growth patterns, and several other significant elements (Kisku *et al.*, 2017).Prior to utilizing the water, it is essential to assess its physical characteristics, including color, taste, temperature, pH and turbidity. Additionally, chemical analyses must be conducted to determine parameters such as Biological Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen, alkalinity, hardness and other relevant properties (Manonmani *et al.*, 2024).

The provision of environmental enrichment in fish aquaria is widely recognized for its beneficial effects on fish welfare (Naslund and Johnson, 2014; Sloman *et al.*, 2019; Jones *et al.*, 2021; Zhang *et al.*, 2021). The incorporation of physical enrichment, specifically structural or substrate enhancements is advised for domestic aquaria. Structural enrichment may consist of shelters vegetation, offering refuge from both intra- and interspecific aggression (Arechavala *et al*., 2021). In certain fish species, the introduction of structural enrichment can influence behavioral development, promote physiological advantages (Thore *et al*., 2020) and facilitate recovery from stressful conditions (Krogh *et al*., 2010).

The physico-chemical parameters of pond aquaculture systems significantly influence the success of aquaculture enterprises. Current data indicated that there has been limited research on the evaluation of these parameters across different ponds in America. Furthermore, it has been noted that many fish farmers lack awareness regarding the importance of these physico-chemical factors for the effective management of their operations and they often do not possess the knowledge necessary to conduct assessments at the appropriate times (Bawa, 2024).Water quality studies play a crucial role in comprehending aquatic ecosystems and are essential for the effective development and management of aquatic environments. Consistent monitoring of water quality parameters is vital to ensure that fish thrive in their habitats. Variations in these parameters can significantly influence the growth, survival and distribution of fish populations (Ufodike and Garba, 1992). Currently, there are widespread issues in aquaculture, such as blindly selecting feed, high feed conversion ratios, and significant impacts on water environments. These issues are not conducive to the sustainable development of the aquaculture industry (Wang *et al.,* 2025).

The guppies and rosy barb, scientifically known as *Poecilia reticulata* and *Pethia conchonius*, belongs to the Cyprinidae family. This species is indigenous to the rivers and swift streams of Afghanistan, Pakistan, India, Nepal and Bangladesh and has gained significant popularity among aquarists globally. The rosy barb exhibits a brief generation cycle and produces a substantial quantity of large, transparent eggs that undergo external fertilization. Consequently, it is emerging as a promising model organism for experimental biological and biotechnological studies. This examines various water and sediment content parameters in the habitats of these fish and to explore any potential correlations between the physico-chemical parameters and the composition of fish assemblages.

Materials and methods

Fish collected and maintained

The guppy and rosy barb fish were sourced from a commercial ornamental fish farm, specifically Angel Aquarium located near the new bus stand in Thanjavur, Tamil Nadu.

These fish were reared in a laboratory setting, where their fry were collected and maintained in a culture tank. The fish underwent acclimatization in well water that was supplied to the laboratory as dechlorinated water. During the acclimatization phase, The experimental diets included probiotics (T1), *Spirulina* (T2), synthesized zinc oxide naon particle from *Spirulina* (T3), *Cynodon dactylon* (T4), and synthesized zine oxide nanoparticles from *C. dactylon* (T5), combination feed (T6). The aquariums were thoroughly cleaned and water changes were conducted at every 15-days interval. All these preparatory steps were completed prior to the commencement of the *in vitro* experiments.

Physico-chemical parameters

The water samples were collected from fish tank and studied at different intervals by composite sampling method using labeled glass container of twenty five liter capacity.

The method adopted for different physic-chemical parameters were followed according to the procedure described in the (APHA *et al*., 1998).

The Physico-chemical parameters were analyzed by pH with Digital pH meter, Temperature (°C) by thermometers, Turbidity measured in (NTU) Nephello Turbid Meter.

Ammonia (mg L^{-1}) by spectrophotometer

Each experiment was conducted in a 10 mL colorimetric tube. The NaOH solution, ammonium solution and potassium bromate solution were added in sequence, with thorough mixed after each trials. Subsequently, the solution was allowed to stand for several minutes.

Following this, sulfanilamide solution and N-1-naphthylethylenediamine dihydrochloride solution were added one after the other and the mixture was homogenized. The volume was then diluted to 10 mL with deionized water and allowed to sit for 15 minutes at 25°C for color development. Finally, the absorbance of these solutions was measured at 543 nm using a UV-Visible spectrometer (A). A blank sample was prepared similarly, but with the omission of the ammonium solution. Measurements of the blank sample were also taken by using the UV-Visible spectrometer (A0). A calibration curve was established with various concentrations of ammonia nitrogen, plotting the ammonia nitrogen concentration on the horizontal axis and the absorbance value (A–A0) on the vertical axis. Finally, the ammonia nitrogen concentration in the sample water was deduced from the calibration curve.

Electrical conductivity (μmhos/cm) by EC meter

The electrical conductivity was measured using an electrical conductivity meter (EC meter). First, verified the EC meter's functionality with a potassium chloride (KCl) solution at 0.01 M: Dissolve 0.7456 grams of KCl in distilled water and adjust the total volume to 1 liter at 25°C. This solution serves as a standard reference solution. At 25°C, this solution has an electrical conductivity of 1.412 dS m-1. Pour 75 mL of the water sample into a beaker, then place the clean and dried conductivity cell into the beaker. Take the reading, allowing some time for the display to stabilize before recording the measurement. The EC value can be used directly for categorizing the water based on salinity, or it can be used to determine the concentration using the formula provided.

Total soluble salt content (mg L^{-1}) =EC (dS m^{-1}) at 25 ^{o}C × 640

Total salt content L^{-1} (approximately) =EC (dS m^{-1}) at 25 ^{o}C × 10

Dissolved oxygen (mg L^{-1}) using standard Winkler method by titration

Dissolved oxygen levels were measured using the azide modification of Winkler's method. A 200mL sample of water was carefully placed into a 300 mL BOD bottle. One milliliter of manganese sulfate solution was added followed by one milliliter of the alkaline alkali-iodide-azide reagent. The resulting solution was titrated with 0.025N sodium thiosulfate until a color change indicated the end point. The titrated value was noted as dissolved oxygen (DO).

BOD (mg L^{-1}) by titration

The biochemical oxygen demand was measured using the azide modification of Winkler's technique. A BOD bottle was set up and incubated at 20°C for duration of five days in the absence of light. After the five-day incubation period, 2 mL of orthophosphoric acid was added to the BOD bottle while mixing. This solution was gently shaken and then titrated with sodium thiosulphate until a color change indicated the endpoint. The volume used in the titration reflects the dissolved oxygen after five days. The BOD was calculated by determining the difference between the dissolved oxygen levels on the first and fifth days.

COD (mg L^{-1}) open condensation and digestion by titration

Determination of COD was done as per standard methods. 50 ml of the water sample was taken in a reflux flask and 10mL of potassium dichromate solution with 1 g mercuric sulphate was thoroughly mixed. Antibumping beads were added to control boiling of the solution. To this, 10mL of concentrated sulphuric acid containing silver sulphate was added through the open end of the condenser carefully and mixed by swirling motion. The reflux apparatus was operated for around 1 hour and allowed to cool. The flask was removed and its content was diluted to 150mL with distilled water. The resulted solution, three drops of the ferroin indicator were added. The sample was titrated with standard ferrous ammonium sulphate and end point where blue-green colour just changed to reddish-brown. Chemical oxygen demand (COD) of the blank sample was then calculated.

Total alkalinity (mg L^{-1}) by titration method

The values of alkalinity are assessed using titration techniques. A volume of 50 ml of the water sample was placed in a clean 150 ml conical flask, and three drops of phenolphthalein indicator were added. Subsequently, it was titrated with 0.05M H_2SO_4 until the solution turned colorless. After achieving a colorless solution, three drops of methyl orange indicator were introduced and titration continued until the color shifted from yellow to a stable reddish at which point the titrated values were noted and the alkalinity was calculated.

TDS (mg/L) by gravimetric method

The total dissolved solids were calculated by taking the total solids of the samples and subtracting the values of suspended solids. The total suspended solids were measured by filtering using Whatman filter paper that had been rinsed with double distilled water and then dried in an oven at 105°C for precisely one hour before being cooled in desiccators. The weight of the residue (W1) was measured with a digital balance. A 100 mL sample of water was passed through the resin paper and then evaporated at 105°C for one hour. The weight recorded for W2, which reflects the filter paper along with the residue was noted and the TSS was computed using the formula (W2 − W1) × 100 mg/L. Total hardness (mg L-1) by using EDTA complexometric by titration was measured between 15 days for four intervals.

Statistical analysis

Along with beneficial resources of the Statistical Package for Social Sciences (version 22), one-way ANOVA at the 95% level ($P \leq 0.05$) was used to statistically evaluate for significant differences between mean values.

Results and discussion

In the present study, there are approximately 12 glass tanks (24 × 12 inches) and 7 treatments (T1-T6 Treatments and Control) from two different ornamental fishes like *Poecilia reticulata* (Guppy) and *Pethia conchonius* (Rosy Barb) at four intervals were cultivated and recorded respectively. In physicochemical parameters such as pH, temperature, ammonia, electrical conductivity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total alkalinity, turbidity, total dissolved solids and total hardness, the 12 fish tank waters were analyzed at different intervals such as 15, 30, 45 and 60 days.

pH serves as a crucial limiting factor in aquaculture, reflecting the acid-base equilibrium of the water. The survival and growth of fish are significantly influenced by the water's pH level. The optimal pH range for fish growth is identified as being between 7.5 and 8.5; deviations from this range can induce stress in the fish population. A similar pH range of 7.3 to 8.3 was reported by Kamal *et al.* (2007). The pH ranges were observed to range varied between fluctuations of 6.9 to 8.3 in all intervals of 12 fish tanks. The pH levels measured in water samples with an average of 7.8 (refer to Table 1, 3, 5 & 7).

An understanding of the maximum and minimum water temperatures of a water body is crucial for successful fish culture. As ectothermic organisms, fish experience fluctuations in body temperature in accordance with their surrounding environment, which in turn impacts their metabolism and physiological functions, ultimately affecting production levels (Bhatnagar and Devi, 2013). These temperatures are notably lower than the optimal range of 28 to 30 °C recommended in the Target Guidelines which is associated with enhanced growth rates, improved food conversion efficiency, optimal fish condition, increased disease resistance and greater tolerance to toxins (metabolites and pollutants) (South African Water Quality Guidelines, 1996). In the current study, the temperature measurements was observed to range from 25.3°C to

32.3°C, which is consistent with the guidelines established for water quality management in fish culture in Guppy and Rosy barb (as shown in Table 1, 3, 5 & 7), with an average of 32.0°C.

Ammonia is a by-product resulting from the metabolism of proteins which is excreted by fish and produced through the bacterial breakdown of organic materials, including uneaten food, feces, deceased plankton and sewage. The un-ionized form of ammonia (NH_3) was highly toxic, whereas the ionized form (NH^{4+}) and both forms are collectively referred to as "total ammonia" (Bhatnagarand Devi, 2013). In Australia, New Zealand and South Australia, the standard for ammonium (NH^{4+}) is established at less than 1.0 mg/L for both freshwater and marine environments (PHILMINAQ, 2014). In the analyzed samples, the ammonium levels varied between 24.0to40.2 mg/L (as shown in Table 1, 3, 5 & 7) with an average of 35.0mg/L when compared to the recommended ammonia. This parameter was deemed acceptable for the growth of fish.

Table 1. Physico-chemical parameters of water for ornamental fish from 15th day interval

Parameters	15th day													
	Poecilia reticulate (Guppy)							*Pethia conchonius* (Rosy Barb)						
	Control	T1	T2	T3	T4	T5	T6	Control	T1	T2	T3	T4	T5	T6
pH	7.0	6.9	7.5	7.7	7.8	7.6	7.4	7.8	7.2	7.6	7.6	7.4	7.7	7.4
Temp.(ºC)	26.1	29.1	32.1	30.6	32.2	30.7	29.6	25.9	29.3	30.2	32.5	32.1	30.3	29.5
Ammonia (mg/L)	24.0	26.9	34.1	29.1	38.6	38.6	28.2	31.2	30.2	32.2	34.7	36.1	36.1	32.8
EC(μmhos/cm)	120.1	136.7	140.8	140.1	142.1	150.4	135.3	321.0	360.1	335.2	341.2	354.2	350.6	356.7
DO (mg/L)	7.6	7.3	7.3	7.5	7.7	7.4	7.6	5.6	4.6	5.2	5.2	5.7	5.5	4.9
BOD (mg/L)	4.0	4.2	4.6	4.4	4.9	5.2	4.3	3.0	3.1	5.0	3.6	3.9	7.9	3.3
COD (mg/L)	1.2	1.7	3.6	2.5	4.1	4.9	1.9	9.5	9.9	10.5	11.4	10.4	11.4	10.2
TA(mg/L)	50.1	50.3	52.6	54.2	57.3	58.2	51.6	72.4	72.5	71.8	75.3	78.3	80.4	73.2
Turbidity (NTU)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (mg/L)	90.2	90.8	112.8	98.1	108.3	115.2	92.1	171.2	171.8	171.1	166.2	160.4	154.2	172.3
TH(mg/L)	100.0	121.0	136.4	145.1	140.6	137.1	130.3	114	116	127.9	124	133	153	126

ND- Not Detected, T1- Probiotics, T2- *Spirulina*, T3- Synthesized zinc oxide nanoparticles from *Spirulina*, T4- *Cynodon dactylon*, T5- Synthesized zinc oxide nanoparticles from *C. dactylon*, T6- T1+T2+T3+T4+T5; DO= Dissolve oxygen, EC- Electrical conductivity, TA= Total Alkalinity, TH= Total hardness.

Table 2. Pearson correlation coefficient of physicochemical parameters of water for ornamental fish from 15th day interval

Correlation	pH	Temp (˚C)	Ammonia (mg/L)	EC (μmhos/cm)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TA (mg/L)	TDS (mg/L)	TH (mg/L)
pH	1									
Temp (˚C)	0.345147	1								
Ammonia (mg/L)	0.674904	0.687073	1							
EC (μmhos/cm)	0.199938	0.124376	0.338656	1						
DO (mg/L)	-0.08386	-0.04314	-0.21799	-0.97482	1					
BOD (mg/L)	0.292436	0.275064	0.382584	-0.11794	0.221777	1				
COD (mg/L)	0.357039	0.240128	0.518819	0.973032	-0.92726	-0.00425	1			
TA (mg/L)	0.362662	0.238868	0.513153	0.969484	-0.90119	0.060364	0.989828	1		
TDS (mg/L)	0.296028	0.090343	0.404185	0.973261	-0.95904	-0.21251	0.969129	0.945478	1	
TH (mg/L)	0.617172	0.680851	0.637966	0.010941	0.110226	0.713837	0.132495	0.182097	-0.037	1

Temp.- Temperature, EC- Electrical conductivity, DO- Dissolved Oxygen, BOD- Biochemical oxygen demand, COD- Chemical oxygen demand, TA- Total alkalinity, TDS- Total dissolved solids, TH- Total hardness.

Conductivity serves as a measure of the overall ionic content present in water, thereby reflecting its freshness or lack thereof (Egborge, 1994; Ogbeibu and Victor, 1995). In this study, the electrical conductivity of the saline waters in Guppy and Rosy barb varied from 120.1 to 164.8 (μmhos/cm) and 321.0 to 362.4 (μmhos/cm), with an average value of 140.1 and 341.2(μmhos/cm)(as shown in Table 1, 3, 5 & 7) found to be recorded respectively. The variations in electrical conductivity were attributed and changed in total dissolved solids (TDS) and salinity levels (Boyd, 1981).

Table 3. Physico-chemical parameters of water for ornamental fish from 30th day interval

Parameters	30th day													
	Poecilia reticulate (Guppy)							*Pethia conchonius* (Rosy Barb)						
	Control	T1	T2	T3	T4	T5	T6	Control	T1	T2	T3	T4	T5	T6
pH	7.2	7.1	7.4	7.3	7.5	7.2	7.8	7.9	7.5	7.6	7.8	7.9	7.3	7.9
Temp.(°C)	28.2	29.5	31.5	32.8	30.0	32.8	29.9	26.7	29.4	29.8	30.1	30.4	31.2	29.7
Ammonia (mg/L)	26.1	27.2	35.7	31.2	37.8	37.8	29.4	32.0	31.3	36.4	35.1	37.8	37.8	33.2
EC(μmhos/cm)	136.2	140.2	148.2	148.5	146.4	156.2	138.1	362.4	342.1	337.1	350.3	349.5	339.2	352.6
DO(mg/L)	7.4	7.7	7.6	8.0	7.5	7.8	8.2	4.8	5.3	5.4	5.8	5.5	5.7	5.5
BOD (mg/L)	3.0	3.9	3.6	3.9	5.9	6.3	3.7	2.0	2.6	5.1	4.2	4.6	7.2	2.9
COD (mg/L)	1.6	1.9	2.8	2.9	4.6	4.2	2.3	11.5	12.1	11.2	12.2	11.2	12.6	11.5
TA(mg/L)	51.2	51.5	52.4	53.1	54.6	56.2	52.7	72.9	73.2	74.3	77.1	75.7	81.3	75.4
Turbidity (NTU)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (mg/L)	91.5	91.7	114.1	96.4	106.2	120.8	93.0	173.6	172.2	152.7	161.0	167.2	157.6	174.6
Total hardness (mg/L)	106.0	123.6	140.3	143.2	145.6	135.2	133.4	132	128	141	138	140	150	130

ND- Not Detected, T1- Probiotics, T2- *Spirulina*, T3- Synthesized zinc oxide nanoparticles from *Spirulina*, T4- *Cynodon dactylon*, T5- Synthesized zinc oxide nanoparticles from *C. dactylon*, T6- T1+T2+T3+T4+T5; DO= Dissolve oxygen, EC- Electrical conductivity, TA= Total Alkalinity, TH= Total hardness

Table 4. Pearson correlation coefficient of physicochemical parameters of water for ornamental fish from 30th day interval

Correlation	pH	Temp. (˚C)	Ammonia (mg/L)	EC (μmhos/cm)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TA (mg/L)	TDS (mg/L)	TH (mg/L)
pH	1									
Temp. (˚C)	-0.37661	1								
Ammonia (mg/L)	0.239285	0.454116	1							
EC(μmhos/cm)	0.631532	-0.28444	0.385321	1						
DO(mg/L)	-0.57996	0.447489	-0.29958	-0.97135	1					
BOD (mg/L)	-0.3834	0.666924	0.700389	-0.18153	0.2686	1				
COD(mg/L)	0.582125	-0.1925	0.503283	0.98323	-0.946	-0.04511	1			
TA(mg/L)	0.554662	-0.149	0.500123	0.976428	-0.922	0.015429	0.986884	1		
TDS (mg/L)	0.620196	-0.23563	0.463219	0.978532	-0.958	-0.15198	0.975497	0.950388	1	
TH (mg/L)	0.208647	0.543756	0.788335	0.246694	-0.1150	0.626516	0.358766	0.362204	0.254084	1

Temp.- Temperature, EC- Electrical conductivity, DO- Dissolved Oxygen, BOD- Biochemical oxygen demand, COD- Chemical oxygen demand, TA- Total alkalinity, TDS- Total dissolved solids, TH- Total hardness.

Dissolved oxygen refers to the quantity of gaseous oxygen that is present in an aqueous solution which is crucial for the biological processes of cultured organisms. Among the various dissolved gases in water, oxygen is paramount for the survival of organisms in aquaculture settings (Dhawan and Karu, 2002).The dissolved oxygen values observed in this study are consistent with findings from previous research, which indicated that a minimum of 5 mg/l is necessary for ornamental fish (Saloom and Duncan, 2005). In the current study, the dissolved oxygen levels were found to range from 4.6 to 8.2 mg/L. As illustrated in as shown in Table 1, 3, 5 & 7, the DO levels in the waters of Guppy and Rosy barb varied from 4.6 to 8.2 mg/L, with an average of 7.2 mg/L. Given the aforementioned findings indicating that DO concentrations of 5.0 mg/L and above are favorable for ornamental fish survival, the levels recorded in this study are considered adequate for supporting aquatic biodiversity.

The Biochemical Oxygen Demand (BOD) refers to the quantity of oxygen consumed by microorganisms as they break down organic waste in water. This measurement serves as an indicator of both sewage and industrial contamination. In the present study, BOD values of guppy and rosy barb were found to be ranged from 2.0 mg/l to 8.2 mg/l which aligned with the recommended standards were analyzed (Table 1, 3, 5 & 7). However, reference APHA (1992)states that the acceptable BOD limit is 4 mg/l. Elevated levels of BOD can lead to stress, suffocation and potential mortality in aquatic organisms, a situation that was not observed in this study.

Table 5. Physico-chemical parameters of water for ornamental fish from 45th day interval

Parameters	45th day													
	Poecilia reticulate (Guppy)							*Pethia conchonius* (Rosy Barb)						
	Control	T1	T2	T3	T4	T5	T6	Control	T1	T2	T3	T4	T5	T6
pH	7.8	7.5	7.2	8.2	8.0	7.9	7.8	8.0	8.1	7.6	8.0	8.1	7.5	8.3
Temp.(°C)	26.3	28.4	30.7	28.6	31.6	29.1	32.3	25.3	28.3	30.4	31.8	32.0	31.1	28.1
Ammonia (mg/L)	27.3	28.3	33.4	29.1	33.1	35.6	35.6	30.5	32.8	34.7	36.9	35.5	35.5	32.2
EC(µmhos/cm)	149.1	142.0	156.4	145.8	155.2	151.8	161.1	341.8	341.7	340.1	342.5	348.2	328.1	348.1
DO(mg/L)	7.7	7.8	7.6	7.9	7.3	7.0	7.3	5.7	5.1	5.5	5.4	5.2	5.0	5.6
BOD (mg/L)	2.0	2.4	4.1	2.2	2.7	3.2	6.5	2.0	2.9	5.2	3.9	5.6	7.6	3.3
COD (mg/L)	1.8	2.2	4.6	2.9	3.4	4.4	5.3	12.4	12.7	12.5	13.1	12.5	13.2	12.5
TA(mg/L)	53.6	53.7	52.3	54.4	55.7	57.6	62.7	73.4	73.8	77.8	79.4	80.2	83.7	77.2
Turbidity (NTU)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (mg/L)	96.0	96.5	98.6	95.1	92.7	102.7	122.1	182.0	184.5	156.7	168.5	163.2	153.0	188.2
TH(mg/L)	96.0	100.0	144.8	113.5	153.7	150.2	140.9	154	161	150	143	148	158	133

ND- Not Detected, T1- Probiotics, T2- *Spirulina*, T3- Synthesized zinc oxide nanoparticles from *Spirulina*, T4- *Cynodon dactylon*, T5- Synthesized zinc oxide nanoparticles from *C. dactylon*, T6- T1+T2+T3+T4+T5; DO= Dissolve oxygen, EC- Electrical conductivity, TA= Total Alkalinity, TH= Total hardness

Table 6. Pearson correlation coefficient of physicochemical parameters of water for ornamental fish from 45th day interval

Correlation	pH	Temp (˚C)	Ammonia (mg/L)	EC (µmhos/cm)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TA (mg/L)	TDS (mg/L)	TH (mg/L)
pH	1									
Temp (˚C)	-0.10516	1								
Ammonia (mg/L)	0.047998	0.767543	1							
EC(µmhos/cm)	0.318028	0.028476	0.406093	1						
DO(mg/L)	-0.21017	-0.15926	-0.5604	-0.96595	1					
BOD(mg/L)	-0.34763	0.71486	0.70853	0.293774	-0.429	1				
COD(mg/L)	0.27072	0.124563	0.52687	0.98544	-0.98	0.402725	1			
TA(mg/L)	0.166053	0.249637	0.586123	0.954332	-0.967	0.554212	0.977869	1		
TDS(mg/L)	0.378677	-0.06071	0.366407	0.964615	-0.913	0.231149	0.956875	0.897326	1	
TH(mg/L)	0.197495	0.373176	0.753822	0.568391	-0.70	0.429199	0.658525	0.617393	0.554443	1

Temp.- Temperature, EC- Electrical conductivity, DO- Dissolved Oxygen, BOD- Biochemical oxygen demand, COD- Chemical oxygen demand, TA- Total alkalinity, TDS- Total dissolved solids, TH- Total hardness.

The Chemical Oxygen Demand (COD) of water indicated the quantity of oxygen necessary to chemically oxidize all forms of organic matter including both biodegradable and non-biodegradable substances using a potent chemical oxidant. This measurement serves as a marker for the presence of sewage and industrial pollutants. In the current study, the COD values were observed to range from

1.2 mg/l to 13.2mg/L (Table 1, 3, 5 & 7). Alkalinity refers to the total concentration of negative ions that interact to neutralize hydrogen ions when an acid is introduced to water. Proper liming will manage the concentration of alkalinity. In the current study, the measured alkalinity values ranged from 20.1 to 35.4mg/L, which aligns with the established guidelines for water quality management in fish culture in guppy and rosy barb.

Turbidity denotes the reduced capacity of water and allowed light to pass through, which is attributed to the presence of suspended particles and phytoplankton. As noted by a turbidity level of 20-30 NTU is considered appropriate for fish culture. However, our findings indicated a slightly higher turbidity compared to those reported by Zweigh (1989). In the current study, turbidity was not detected in guppy and rosy barb fish tank water sample. Total solids encompass all matter that is either dissolved in water. Dissolved solids (DS) consist of substances such as bicarbonate, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions and other ions essential for aquatic life. In guppy and rosy barb, the concentration of total dissolved solids (TDS) varied between 90.2 mg/L and 178.2 mg/L averaging 36.76 mg/L (as shown in Table 1, 3, 5 & 7).

Table 7. Physico-chemical parameters of water for ornamental fish from 60th day interval

Parameters	60th day													
	Poecilia reticulate (Guppy)							*Pethia conchonius* (Rosy Barb)						
	Control	T1	T2	T3	T4	T5	T6	Control	T1	T2	T3	T4	T5	T6
pH	7.6	7.3	7.6	7.4	7.1	7.5	7.6	7.7	7.4	7.5	7.2	7.7	7.5	7.6
Temp.(ºC)	26.9	29.3	30.2	31.2	32.1	32.1	29.2	26.4	29.1	30.8	30.2	32.3	29.5	30.5
Ammonia (mg/L)	28.9	27.4	32.6	30.3	34.9	34.9	28.9	30.6	31.7	38.7	31.0	40.2	30.7	40.2
EC(µmhos/cm)	141.5	141.6	146.7	149.4	144.7	164.8	139.4	341.8	351.5	348.1	345.6	343.2	355.9	353.6
DO(mg/L)	7.8	7.2	7.5	7.7	7.6	7.9	7.4	5.1	4.9	6.5	6.0	6.2	5.9	6.6
BOD(mg/L)	5.0	5.6	5.6	6.2	5.1	6.6	5.8	4.0	4.4	5.3	4.1	4.8	4.5	8.2
COD(mg/L)	1.7	1.8	4.8	3.5	4.5	5.8	1.5	9.2	9.5	9.8	10.2	9.6	9.9	10.7
TA(mg/L)	54.3	54.8	56.3	56.0	56.5	58.3	56.4	74.6	74.3	84.2	77.2	83.1	74.9	85.4
Turbidity (NTU)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TDS (mg/L)	93.4	93.5	98.1	96.2	104.3	114.5	92.6	178.1	176.6	169.7	172.0	170.3	178.2	160.8
TH(mg/L)	104.0	113.4	148.2	150.5	157.1	146.2	120.2	163	172	158	146	152	156	162

ND- Not Detected, T1- Probiotics, T2- *Spirulina*, T3- Synthesized zinc oxide nanoparticles from *Spirulina*, T4- *Cynodon dactylon*, T5- Synthesized zinc oxide nanoparticles from *C. dactylon*, T6- T1+T2+T3+T4+T5; DO= Dissolve oxygen, EC- Electrical conductivity, TA= Total Alkalinity, TH= Total hardness

Table 8. Pearson correlation coefficient of physicochemical parameters of water for ornamental fish from 60th day interval

Correlation	pH	Temp (˚C)	Ammonia (mg/L)	EC (µmhos/cm)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TA (mg/L)	TDS (mg/L)	TH (mg/L)
pH	1									
Temp.(˚C)	-0.35245	1								
Ammonia (mg/L)	0.224793	0.613607	1							
EC(µmhos/cm)	0.26676	-0.09526	0.413528	1						
DO(mg/L)	-0.1886	0.344728	-0.07786	-0.88174	1					
BOD(mg/L)	0.137791	0.38032	0.41392	-0.27708	0.536674	1				
COD(mg/L)	0.155812	0.111272	0.55677	0.958711	-0.77717	-0.1695	1			
TA(mg/L)	0.32337	0.052737	0.605579	0.961412	-0.75904	-0.087	0.941588	1		
TDS (mg/L)	0.234517	-0.08938	0.384014	0.986926	-0.90113	-0.369	0.962199	0.923882	1	
TH (mg/L)	-0.04153	0.298359	0.530927	0.677736	-0.61367	-0.062	0.793428	0.646094	0.715192	1

Temp.- Temperature, EC- Electrical conductivity, DO- Dissolved Oxygen, BOD- Biochemical oxygen demand, COD- Chemical oxygen demand, TA- Total alkalinity, TDS- Total dissolved solids, TH- Total hardness.

The hardness of water was influenced by the presence of dissolved solids and pH levels. It serves as an indicated the total concentration of divalent metallic cations such as calcium, magnesium and strontium. Appropriate liming practices can help to mitigate hardness issues (Wurts and Durbow, 1992). In the current study, hardness ranged from 80 to 110 mg/l, which aligns and measured. However, a previous study indicated that hardness levels between 96.0 and 162 mg/L (as shown in Table 1, 3, 5 & 7).

The variation in the concentrations of physicochemical parameters between the field and laboratory water was significant for EC, Turbidity and TDS at $p < 0.05$ (Awoyemi *et al.*, 2014). In the current investigation, the correlation coefficient among various physicochemical parameters of pH, temperature, ammonia, electrical conductivity (EC), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total alkalinity (TA), turbidity, total dissolved solid (TDS) and total hardness (TH) of two control fish tanks (Guppy and Rosy barb) from different intervals. This analysis, known as Pearson's correlation analysis (r), assesses the degree of linear relationship between two quantitative variables. It offers insights into the strength of the linear association between the variables. The correlation values can range from -1 to +1, where +1 indicates a perfect positive linear relationship, 0 signifies no linear relationship, and -1 reflects a perfect negative linear relationship. A positive correlation among the physicochemical parameters was observed at a significance level of $p<0.05$, while a negative correlation with the two fish tanks of different intervals was also noted at the same significance level were observed.

In this study, the correlation coefficient of the physicochemical parameters of 15th day from ornamental fish tank water was found to be significant at the total hardness, with a significance level of $p < 0.05$ (Table 2). The correlation coefficient of physicochemical parameters of ornamental fish tank water from 30th day intervals was correlated at the COD and total alkalinity that was observed at a significance level of $p < 0.05$ (Table 4). The correlation coefficient of the physicochemical parameters from ornamental fish tank water from 45th day intervals was found to be significant at the ammonia and electrical conductivity with a significance level of $p < 0.05$ (Table 6). The correlation coefficient of physicochemical parameters of two ornamental fish tanks from 60th day intervals was correlated at the total alkalinity and total hardness that was observed at a significance level of $p < 0.05$ (Table 8).

Conclusion

The present research was carried out in the physico-chemical parameters of water and fish growth in 14 glass tanks was investigated. The physicochemical characteristics of water are utilized and assessed water quality and safeguard the well-being of fish within a tank.

Overall, the physico-chemical parameters such as pH, temperature, ammonia, electrical conductivity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, total alkalinity, turbidity, total dissolved solids and total hardness were found to be within suitable ranges and support aquatic life. The generation of dissolved oxygen in aquatic environments directly influences fish growth. Achieving optimal fish productivity was contingent upon maintaining the physical, chemical and biological properties of tank water within suitable parameters with a pH range of 6 to 9 being the most effective for ornamental fish cultivation by *in vitro* experiments. All parameters exhibited significant interconnections as determined by the correlation analysis of physicochemical analysis of water, referred to as Pearson's Correlation matrix. Both positive and negative correlation coefficients ($p<0.05\%$) were observed. However the some parameters of pH, DO, BOD, COD and total alkalinity were recognizing factors for ornamental fish farm.

References

Anka IZ, Jothi JS, Sarker J, Talukder A, Islam S. 2016. Growth performance and survival of guppy (*Poecilia reticulata*): Different formulated diets effect. Asian Journal of Medical and Biological Research **2**(3), 451–457. https://doi.org/10.3329/ajmbr.v2i3.30117

Annasari M, Aris WM, Yohanes K. 2012. Albumin and zinc content of snakehead fish (*Channa striata*) extract and its role in health. IEESE International Journal of Science and Technology **1**(2), 1–8.

AOAC. Official Methods of Analysis of Association of Official Analytical Chemists, 18th edition. AOAC, Arlington, Virginia, USA.

APHA, AWWA, WPCF. 1998. Standard Methods for the Examination of Water and Waste Water, 20th Edition. APHA, New York, USA.

APHA. 1992. Standard Methods for the Examination of Water and Waste Water, 18th Edition. American Public Health Association, Washington, D.C., 874p.

Arechavala-Lopez P, Maia CM, Saraiva JL. 2021. Environmental enrichment in fish aquaculture: A review of fundamental and practical aspects. Reviews in Aquaculture **14**, 704–728.

Awoyemi OM, Uwafili PN, Izegaegbe JI, Fadeyi OP. 2014. Analysis of the foraging behavior of guppy (*Poecilia reticulata*) in relation to its use as a biological method for the environmental control of mosquito larvae. International Journal of Recent Research and Applied Studies **21**(3), 103–113.

Bawa DY. 2024. Analysis of water physico-chemical parameters in Jega Local Government Area fish farms of Kebbi State, Nigeria. American Research Journal of Contemporary **2**(2), 1–7.

Bhatnagar A, Devi P. 2013. Water quality guidelines for the management of pond fish culture. International Journal of Environmental Sciences **3**(6), 1980–2009.

Boyd CE, Lichtkoppler F. 1979. Water quality management in fish ponds. Research and Development Series No. 22. International Centre for Aquaculture (JCAA), Experimental Station, Auburn University, Alabama, 45–47.

Boyd CE. 1981. Water quality in warm water fish ponds. Crftmaster Printer, Inc., Opelika, Alabama, USA.

Capel B. 2017. Vertebrate sex determination: Evolutionary plasticity of a fundamental switch. Nature Reviews Genetics **18**(11), 675–689.

Carbia PS, Brown C. 2019. Environmental enrichment influences spatial learning ability in captive-reared intertidal gobies (*Bathygobius cocosensis*). Animal Cognition **22**, 89–98.

Dhawan A, Karu S. 2002. Pig dung as pond manure: Effect on water quality, pond productivity and growth of carps in polyculture system. ICLARM Quarterly, Manila **25**(1), 1–14.

Egborge AMB. 1994. Salinity and the distribution of rotifers in the Lagos Harbour–Badagry Creek system, Nigeria. Hydrobiologia **272**, 95–104.

Jones NAR, Webster M, Salvanes AGV. 2021. Physical enrichment research for captive fish: Time to focus on the DETAILS. Journal of Fish Biology **99**, 704–725.

Kamal D, Khan AN, Raham MA, Ahmed A. 2007. Study on physico-chemical properties of water of Mouri River, Khulna, Bangladesh. Pakistan Journal of Biological Sciences **10**, 710–717.

Kasim LI. 2017. Physicochemical parameters of water and their effects on fish production. Journal of Agriculture and Veterinary Sciences **9**(2), 20–31.

Kent M, Ojanguren AF. 2015. The effect of water temperature on routine swimming behavior of newborn guppies (*Poecilia reticulata*). Biology Open **4**(4), 547–552.

Kisku S, Chini DS, Bhattacharya M, Kar A, Parua S, Das BK. 2017. A cross-sectional study on water quality in relation to fish diversity of Paschim Medinipur, West Bengal, India through geoinformatics approaches. The Egyptian Journal of Aquatic Research **43**(4), 283–289.

Lindholm AK, Head ML, Brooks RC, Rollins LA, Ingleby FC, Zajitschek SR. 2014. Causes of male sexual trait divergence in introduced populations of guppies. Journal of Evolutionary Biology **27**(2), 437–448.

Manonmani M, Sathya TA, Anburaj R, Gokilavani K, Geethanjali PS, Viswanathan S. 2024. Seasonal impact on physico-chemical parameters of fresh water resources—A review. International Journal of Biomolecules and Biomedicine **18**(2), 1–10.

Mohideen AKS, Sheriff MA, Altaff K. 2014. Effect of three different feeds on the growth and survival of sailfin molly *Poecilia latipinna* (Lesueur, 1821). Revelation and Science **4**, 45–48.

Munir MB, Hashim R, Manaf MSA, Nor SAM. 2016. Dietary prebiotics and probiotics influence the growth performance, feed utilisation, and body indices of snakehead (*Channa striata*) fingerlings. Tropical Life Sciences Research **27**(2), 111–125.

Näslund J, Johnson JI. 2014. Environmental enrichment for fish in captive environments: Effects of physical structures and substrates. Fish and Fisheries **17**, 1–30.

Nugroho AA, Muzaki A, Anggraini AI, Haryanti D. 2021. Studi perilaku ikan guppy jantan dan betina (*Poecilia reticulata*) pada masa reproduksi. Teknosains: Media Informasi Sains dan Teknologi **15**(3), 287.

O'Gorman EJ, Ólafsson ÓP, Demars BOL, Friberg N, Gubergsson G, Hannesdóttir ER. 2016. Temperature effects on fish production across a natural thermal gradient. Global Change Biology **22**(9), 3206–3220.

Ogbeibu AE, Victor R. 1995. Hydrological studies of water bodies in the Okomu Forest Reserves (Sanctuary) in Southern Nigeria. 2. Physico-chemical hydrology. Tropical Freshwater Biology **4**, 83–100.

Olivotto I, Tokle NE, Nozzi V, Cossignani L, Carnevali O. 2010. Preserved copepods as a new technology for the marine ornamental fish aquaculture: A feeding study. Aquaculture **308**(3–4), 124–131.

Rahman MM, Kodowaki S, Balcombe R, Wahab MA. 2010. Common carp (*Cyprinus carpio* L.) alters its feeding niche in response to changing food resources: Direct observations in simulated ponds. Ecological Research **25**(2), 303–309.

Rocha FC, Casatti L, Pereira DC. 2009. Structure and feeding of a stream fish assemblage in Southeastern Brazil: Evidence of low seasonal influences. Acta Limnologica Brasiliensia **21**(1), 123–134.

Saloom ME, Duncan RS. 2005. Low dissolved oxygen levels reduce antipredator behaviours of the freshwater clam *Corbicula fluminea*. Freshwater Biology **50**, 1233–1238.

Sangeeta R, Surjya KS. 2023. Characterization of some physico-chemical parameters of water bodies inhabited by small indigenous fish species (SIFs): A case study. European Journal of Aquatic Sciences **2**(3), 2976–7423.

Sloman KA, Bouyoucos IA, Brooks EJ, Sneddon LU. 2019. Ethical considerations in fish research. Journal of Fish Biology **94**, 556–577.

Sonila K, Flora Q, Pranvera L, Lirim B. 2015. The effect of physico-chemical parameters and nutrients on fish growth in Narta Lagoon, Albania. Journal of Hygienic Engineering and Design.

South African Water Quality Guidelines. 1996. Agricultural Water Use: Aquaculture, 2nd ed. Department of Water Affairs and Forestry of South Africa, Pretoria, **6**, 185.

Thoré ESJ, Brendonck L, Pinceel T. 2020. Conspecific density and environmental complexity impact behaviour of turquoise killifish (*Nothobranchius furzeri*). Journal of Fish Biology **97**, 1448–1461.

Ufodike EBC, Garba AJ. 1992. Seasonal variations in limnology and productivity of a tropical highland in Jos Plateau, Nigeria. Journal of Aquatic Sciences **7**, 29–34.

Vanderzwalmen M, Daniel SL, Priyadarshini T, Jason M, Dorine D, Khadidja B, Andrew H, Iain M, Alexander ME, Fiona LH, Donna S, Sloman KA. 2022. The effect of substrate on water quality in ornamental fish tanks. Animals **12**(19), 2679.
https://doi.org/10.3390/ani12192679

Vigneeswaran M, Kanagabapathi V, Prabhakaran V. 2010. Food utilization and fecundity of guppy (*Lebistes reticulatus*) fed with bioencapsulated *Artemia franciscana*. Journal of Ecobiotechnology **2**(2), 33–40.

Von Krogh K, Sorensen C, Nilsson GE, Overli O. 2010. Forebrain cell proliferation, behavior, and physiology of zebrafish, *Danio rerio*, kept in enriched or barren environments. Physiology & Behavior **101**, 32–39.

Zhang Z, Gao L, Zhang X. 2021. Environmental enrichment increases aquatic animal welfare: A systematic review and meta-analysis. Reviews in Aquaculture **14**, 1120–1135.

Zweigh RD. 1989. Evolving water quality in a common carp and blue tilapia high production pond. Hydrobiologia **171**, 11–21.