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Research Article

Physicochemical Condition of Jibia Reservoir Inhabited by A Freshwater Snail *Belamya crawshayi*

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ABSTRACT

This study delves into the interactions of the physicochemical parameters and freshwater snail, *Belamya crawshayi* in Jibia Reservoir, Katsina State, Nigeria. Physicochemical parameters of the water and snails were analysed and identified using standard procedures and identifications keys. Analysis of variance and correlation were used in data analysis. Water temperature ranged from 23.2 °C to 25.7 °C, peaking in August. Dissolved oxygen exhibited monthly variation, reaching a peak of 4.53 mg/L in September and a low of 1.45 mg/L in July. Biological Oxygen Demand (BOD) varied significantly, peaking at 2.11 mg/L in August and dipping to 0.55 mg/L in July. Total hardness ranged significantly from 248.38 mg/L in July to 454.75 mg/L in September. Station-wise variations highlighted only to be significantly different, with its peak at station B (488.50 NTU) and a low at station A (422.00 NTU). *Belamya crawshayi* was the sole observed freshwater snail during the study, with the highest abundance (36 individuals) at station C and the lowest (15 individuals each) at stations B and D. Monthly variations in snail abundance were noted, with 39 individuals in July and 19 individuals in August. Correlation analysis unveiled intricate relationships between physicochemical parameters and *Belamya crawshayi* abundance, emphasizing the interplay between environmental conditions and the snail population in Jibia Reservoir. These findings contribute to our understanding of the ecological dynamics of Jibia Reservoir, emphasizing the interplay between physicochemical conditions and the freshwater snail population.

Keywords: Distribution; Species Abundance; Freshwater; Snails; Jibia; Reservoir; Lake; Katsina State

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INTRODUCTION

The freshwater environment, encompassing lakes, ponds, rivers, reservoirs, and creeks, faces threats from various physicochemical factors. These factors, including pressure, temperature, dissolved oxygen, and pH, can significantly impact the flora and fauna, altering their abundance, distribution, and diversity (Auta *et al*., 2023).

Geo-climatic changes play a vital role in determining the occurrence of aquatic organisms, affecting parasite populations in freshwater fishes and snails (Sadauki *et al*., 2023). Water, a crucial natural resource, serves essential roles in sustaining life and fulfilling daily human needs, ranging from household water supply to industrial uses (Sadauki *et al.*, 2022).

Water quality assessment, often done through physicochemical parameters, can benefit from the use of bioindicators like benthic macroinvertebrates, which prove effective in detecting long-term pollution (Benetti, 2012).

Freshwater snails, integral to freshwater ecosystems, contribute to nutrient recycling and serve as food for various species. Reservoir construction, while offering societal and economic benefits, alters the natural ecosystem, impacting the dynamics of snail populations (Auta *et al*., 2018).

Environmental studies on freshwater snails reveal that their population dynamics and ecosystem interactions are influenced by factors such as physical topography, soil structure, hydrography, and physicochemical parameters. Despite their economic and therapeutic significance, freshwater snails receive less attention compared to marine snails (Auta *et al*., 2018).

Freshwater snails play essential roles in various environmental populations, providing economic value and contributing to human and veterinary health. Some species act as vectors for diseases like schistosomiasis, emphasizing the need for attention and research in this area (Auta *et al*., 2018).

In the context of Jibia reservoir in Katsina State, limited research has been conducted on the factors influencing the occurrence and diversity of freshwater snails. This study aims to investigate the distribution and variety of freshwater snails and assess the impact of ecological and biotic factors in the Jibia reservoir, with potential implications for preventive strategies against snail-borne diseases.

MATERIALS AND METHODS

Study Area

The research area; the reservoir is within Jibia Local Government Area of Katsina State, in northern Nigeria. The reservoir and its head work are built across Gada River located about 2.5km south of Jibia town. The reservoir located on the coordinates 13° 04″ 18′N and 07° 15″ 06′E, has a height of 23.5 m, a length of 3,660 m and a total size of 142 million m3.The major reason of building the reservoir is for farming actions and to enhancement irrigation farming during dry season, other purpose including supply of drinkable water, domestic usage and fishing activities (Sadauki *et al*., 2023). For the purpose of this study, four (4) major locations nearby the reservoir were carefully selected: Location A, Location B, Location C, and Location D.

Sampling Stations

Fresh water snail's samples were collected over a period of 3 months in the selected study area. Fresh water snails was collected from four sampling locations of the reservoir; location A, location B, location C and location D. Location A is located at the entry of the reservoir on the channel of River. Location B is located at the middle of the reservoir where human activity is minimal except, agricultural and irrigational activities. Location C is located at the middle of the reservoir where fishing activities take place. Location D is located at the end of the reservoir where human activities take places.

Snail Sampling and Identification

Dissimilar microhabitats in the reservoir and main waterway were comprehensively investigated for snails between 7am-12pm using a long handled scoop net and pair of forceps monthly as described by (Auta *et al*., 2018). Snails along the irrigation channels and farm fields were likewise broadly sampled by use of scoop net and handpicking (mesh size 3 mm – 4 mm) (Brown, 1994). Snails collected from each habitat were kept in labelled specimen bottles and transported to the laboratory of the Federal University Dutsin-Ma, Katsina State for further examination. The snails captured were then identified based on their morphological characteristics with reference to the standard keys of Brown (1994).

Collection and Analysis of Water Sample

Water samples were collected in four sample bottles from sites of snail collections using 2- litre plastic bottles. The water samples were analysed in the Biological laboratory for the selected water quality parameters including; temperature, pH, turbidity, DO, BOD, Total hardness, Electrical Conductivity, and Total dissolved oxygen and they were determined following the methods described by Dauda and Akinwole (2014). All the procedure followed the standard methods (APHA, 2012).

Data Analysis

Data obtained are presented in tables. Results were summarised using descriptive analysis and data were subjected to One-Way Analysis of variance (ANOVA) to test for difference in means and Duncan Multiple Range Test (DMRT) was done for separation of means of physicochemical parameters with months and stations of sample at p=0.05, 95% confidence interval. Correlation analysis was carried out to test for relationship among physicochemical parameters and abundance of freshwater snails.

RESULT

Findings of this study revealed water temperature variations ranging from 23.2 °C to 25.7 °C, with the highest temperatures observed in August. pH levels were documented as 6.48 ppm, 6.54 ppm, and 6.60 ppm in July, August, and September, respectively. Turbidity at the Jibia water site fluctuated between 461.63 cm and 452.50 cm, with the highest value recorded at 461.25 cm. Dissolved oxygen reached its peak in September at 4.53 mg/L, while the lowest values were noted in July at 1.45 mg/L, displaying a significant monthly variation (p=0.000). Biological Oxygen Demand (BOD) reached its highest level in August (2.11 mg/L) and the lowest in July (0.55 mg/L), exhibiting significant monthly variability (p=0.000). Total hardness showed the highest values in September (454.75 mg/L) and the lowest in July (248.38 mg/L), displaying a significant monthly difference (p=0.000). Electrical Conductivity exhibited the highest values in July and September (0.06 Ds/m each) and the lowest in August (0.05 Ds/m), with no significant monthly variation (p=0.092). Total Dissolved Solid displayed the highest values in September (53.00 ppm) and the lowest in July (49.76 ppm), with no significant monthly difference (p=0.603) as presented in Table 1.

In Table 2, the study's findings revealed variations among the four sampled stations. The highest temperature (25.80°C) was recorded at station C, while the lowest temperature (23.97°C) was noted at station A. pH levels reached their highest value at station D (6.65). Turbidity exhibited its highest value at station B (488.50 NTU) and the lowest at station A (422.00 NTU). Dissolved oxygen recorded its highest level at station B (3.60 mg/L) and the lowest at station C (1.40 mg/L). Biological Oxygen Demand was highest at station D (1.70 mg/L) and lowest at station A (1.23 mg/L). Total Hardness of the water reached its highest at station D (382.50 mg/L). Electrical Conductivity showed its highest values at both stations A and B (0.06 Ds/m each) and the lowest at both station C and D (0.05 dS/m). Total Dissolve Solid was highest at station A (56.17 ppm) and lowest at station D (48.50 ppm).

During the three months period of study (July to September, 2019), only one species of freshwater snail, Belamya crawshayi was observed in Jibia Reservoir, with abundance of 86. Highest distribution of 36 at Sampling station C and lowest number of 15 at both Sampling Stations B and D. Among the months of sampling, highest number of 39 was recorded in the month of July and lowest number of 19 in the month of August. These findings are presented in Table 3.

The correlation analysis of physicochemical parameters and the freshwater snail, as presented in Table 4 reveals negative correlation between temperature and dissolved oxygen (-0.304), biochemical oxygen demand (-0.327) and total dissolved solids (-0.306), with a strong positive correlation with the abundance of Bellamya crawshayi (0.496). Turbidity also had negative correlation with dissolved oxygen (-0.046), biochemical oxygen demand (-0.093), electric conductivity (-0.400) and the abundance of Bellamya crawshayi (-0.270). Dissolved oxygen had very strong positive correlation with BOD (0.789) and TH (0.724), and negative correlation with EC (-0.154) and abundance of B. crawshayi (-0.270). Biochemical oxygen demand had strong positive correlation with TH (0.499) and abundance of B. crawshayi (0.435), while a negative correlation with EC (-0.279).

Table 1. Mean ± SD of the physicochemical parameters recorded in Jibia Reservoir by months

Parameters	July	August	September	P-value
Temperature (°C)	$25.70{\pm}2.55^{b}$	$23.20{\pm}1.18^{a}$	$25.58{\pm}1.17^{b}$	0.015
pH	6.48±0.45	6.60±0.23	6.54±0.14	0.711
TUR	461.63±49.93	452.50±43.01	461.25±41.89	0.901
DO (mg/L)	$1.45{\pm}0.04^{a}$	$4.18{\pm}0.36^{b}$	$4.53{\pm}0.57^{b}$	0.000
BOD (mg/L)	$0.55{\pm}0.20^{a}$	$2.11{\pm}0.43^{b}$	$1.54{\pm}0.34^{c}$	0.000
TH (mg/)	$248.38{\pm}96.93^{a}$	$391.88{\pm}82.98^{b}$	$454.75{\pm}60.11^{b}$	0.000
EC (dS/m)	$0.06{\pm}0.05^{ab}$	$0.05{\pm}0.07^{a}$	$0.06{\pm}0.02^{b}$	0.092
TDS (ppm)	49.76±7.25	51.63±7.42	53.00±3.93	0.603

Significant level (P <0.05). The keys used include: Temp= Temperature, TB=Turbidity, DO= Dissolved Oxygen, BOD= Biological Oxygen Demand, TH= Total Hardness, EC= Electric Conductivity, TDS= Total Dissolved Solids

Table 2. Mean ± SD of the physicochemical parameters recorded in Jibia Reservoir by sampling stations

Parameters	Station A	Station B	Station C	Station D	P-value
Temperature (°C)	23.97±2.84	24.20±1.38	25.80±2.66	25.33±1.51	0.360
pH	6.48±0.37	6.40±0.30	6.61±0.21	6.65±0.26	0.434
TB (NTU)	422.00±34.64^{a}	488.50±22.57	458.00±41.46^{a}	465.33±49.42^{ab}	0.050
DO (mg/L)	3.13±1.36	3.60±0.50	1.40±0.65	1.70±0.96	0.953
BOD (mg/L)	1.23±0.83	1.30±0.50	1.40±0.65	1.70±0.96	0.723
TH (mg/L)	358.17±140.18	343.17±152.3	376.17±127.0	382.50±56.49	0.946
EC (dS/m)	0.06±0.01	0.06±0.008	0.05±0.012	0.05±0.015	0.534
TDS (ppm)	56.17±5.74	50.83±5.08	50.33±6.26	48.50±6.62	0.173

Significant level (P <0.05)

Table 3. Abundance and distribution of *Bellamya crawshay* with sampling stations and months in Jibia Reservoir

Species	Sampling Stations				Month of Sampling		
	Station 1	Station 2	Station 3	Station 4	July	August	September
Bellamya crawshayi (86)	26	15	30	15	39	19	28

Table 4. Correlation coefficient (r) of physicochemical parameters and *Bellamya crawshayi*

Parameters	Temp	pH	TB	DO	BOD	TH	EC	TDS
pH	1.66							
TB	0.199	0.091						
DO	-0.304	0.122	-0.046					
BOD	-0.327	0.211	-0.093	0.789**				
TH	-0.059	0.125	0.005	0.724**	0.499*			
EC	0.301	0.052	0.302	-0.154	-0.279	0.122		
TDS	-0.306	0.069	-0.400	0.186	0.122	0.027	0.188	
Bellamya crawshayi	0.496*	0.014	-0.275	-0.270	0.435*	0.117	0.169	0.108

* Correlation is significant at 0.05 levels (2 tailed).
** Correlation is significant at 0.01 level (2 tailed).

DISCUSSION

The findings of this study provide valuable insights into the ecological dynamics of Jibia Reservoir, shedding light on the physicochemical parameters, abundance of *Belamya crawshayi*, and their interrelationships. The water temperature, a critical environmental factor, exhibited fluctuations between 23.2 °C and 25.7 °C, peaking in August. Such variations are essential to monitor as they influence various biological and chemical processes within the aquatic ecosystem, impacting the overall health and behaviour of organisms (Brett, 1971). The observed pH levels, ranging from 6.48 ppm to 6.60 ppm, fall within the acceptable range for freshwater habitats (Eaton *et al*., 2005). However, the pH fluctuations might influence the solubility of chemical compounds and nutrient availability, affecting the overall biodiversity of the ecosystem (Brezonik, 1974).

Turbidity, a measure of water clarity, ranged from 452.50 cm to 461.63 cm, with the highest value at 461.25 cm. Turbidity influences light penetration, impacting aquatic plant growth and the behaviour of organisms. High turbidity levels may affect the feeding efficiency of some species, indirectly influencing the food web dynamics (Dodds *et al*., 2002). Dissolved oxygen (DO) levels showed a significant monthly variation, reaching a peak of 4.53 mg/L in September and a low of 1.45 mg/L in July. Adequate DO is crucial for supporting aerobic life, and variations can impact the metabolic activities of aquatic organisms (American Public Health Association, 1998). The observed Biological Oxygen Demand (BOD) variations, with the highest level in August (2.11 mg/L) and the lowest in July (0.55 mg/L), indicate the organic load on the water and its potential impact on the ecosystem's health (Eckenfelder, 2000).

Total hardness, reflecting the concentration of calcium and magnesium ions, displayed significant monthly differences, with the highest values in September (454.75 mg/L) and the lowest in July (248.38 mg/L). Total hardness can influence the availability of essential minerals for aquatic organisms (Boyd, 2015). Electrical Conductivity (EC) exhibited no significant monthly variation, but the values were within an acceptable range for freshwater systems. EC is indicative of the water's ability to conduct an electric current, providing insights into dissolved ion concentrations (Sawyer *et al*., 2003). Total Dissolved Solid (TDS) displayed no significant monthly differences, suggesting stability in the concentration of dissolved substances (Fetter, 2001).

Station-wise variations revealed further nuances in the ecosystem. The observed negative correlation between temperature and dissolved oxygen, biochemical oxygen demand, and total dissolved solids implies complex interactions between these parameters. Turbidity exhibited negative correlations with dissolved oxygen, biochemical oxygen demand, electrical conductivity, and the abundance of *Belamya crawshayi*. These relationships highlight the intricate balance between water clarity and other ecological factors (Wetzel, 2001). The strong positive correlation between dissolved oxygen and BOD underscores the connection between oxygen availability and organic matter decomposition. Similarly, the positive correlation between BOD and total hardness indicates potential influences on the microbial degradation of organic substances (Randall and Tsui, 2002).

The ecological implications of the findings extend to the abundance and distribution of *Belamya crawshayi*, a freshwater snail observed during the study. The negative correlation between dissolved oxygen and the abundance of *B. crawshayi* suggests that oxygen availability may influence the distribution and behaviour of this species. Additionally, the positive correlation between BOD and the abundance of *B. crawshayi* implies that organic matter might contribute to the snail's habitat preferences. These correlations emphasize the sensitivity of freshwater snails to environmental conditions, aligning with previous studies on their ecological responses (Ochieng and Cohen, 2008; Saarman *et al*., 2012).

Conclusions

In conclusion, the study's scientifically robust findings contribute to our understanding of the intricate relationships between physicochemical parameters and the freshwater snail population in Jibia Reservoir. The observed variations underscore the dynamic nature of aquatic ecosystems, emphasizing the need for continued monitoring and management strategies to preserve biodiversity and ecosystem health.

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Conflict of Interest

The authors declare that there is no competing interests.

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