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EFFECT OF LAKE WATER CONTAMINATION ON HEMATOLOGICAL PARAMETERS OF FISH, NILE TILAPIA (*Oreochromis niloticus*) FROM FIVE DIFFERENT LAKES OF HYDERABAD CITY.

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ABSTRACT

This study focuses on the Nile tilapia, which is a common fish species found in the lakes of Hyderabad city. The study is to investigate the hematological parameters of Nile tilapia from different locations of Hyderabad city with different levels of contamination. Nile tilapia is adaptable to exist in a variety of environmental situations because of their wide range of adaptive abilities. Fish hematological parameters are crucial health status markers and may be used to evaluate the impact of environmental stresses like pollution. Blood parameters are considered the most vital markers of the physiological stress that reflect the endogenous or exogenous changes in fish and serve as a proxy measure of water contamination as shown in various previous studies. Since blood is a perfect mirror several changes occur in blood parameters because of the contamination, which include changes in RBC count, hematocrit ratio, and hemoglobin (Hb) values. which represent the fish's health. The Nile tilapia is a frequent fish species found in the lakes of Hyderabad city.

This study aims to determine the hematological characteristics of Nile tilapia from five different urban water bodies of Hyderabad city. Five lakes in Hyderabad city were selected for the collection of the Nile tilapia samples for this study. These lakes include Himayat Sagar, Osman Sagar,Shamirpet Lake, Mir Alam Tank, Saroornagar Lake. According to our research, Nile tilapia's hematological parameters are greatly impacted by water pollution. Significant variations in hematological markers found in fish from various lakes suggest that Hyderabad's lakes have varying levels of pollution. This study did not look into the particular pollutants that caused the observed alterations in hematological markers. However, earlier research has shown that hazardous chemicals, organic pollutants, and heavy metals might alter the hematological parameters of fish.

Keywords: *Nile tilapia, water pollution, blood parameters, aquaculture.*

1. INTRODUCTION

Water pollution is a cause of concern across the world and is one of the most prominent environmental challenges , world is facing today. The problem is especially severe in densely populated areas where urbanization and industrialization has led to the discharge of waste into water bodies (Rashi Miglani, Nagma Parveen, 2022). Toxic Effluents in water bodies have a negative impact on both flora and fauna. Contamination of fresh water bodies affects both human health as well as aquatic life (Singh R.K Sarkar, U.K. & Chaudhary S.K., 2013).

Fishes are extensively used as biomonitoring organisms in ecotoxicological studies as they are sensitive and very vulnerable to alterations of water quality, which is reflected in their blood components. The distribution, reproduction,endurance and normal metabolism of fish depend on water quality

parameters as indicated by APHA *(American Public Health Association)* AWWA *(American Water Works Association)*& WEF *(Water Environment Federation)* 2017.

Tilapia is native to Africa and Middle East, and has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world. The farming of tilapias, especially of Nile tilapia (Oreochromis niloticus) is believed to have originated more than 4000 years ago from Egypt (Pal P. Mukherjee D. & Mondal P., 2019). Tilapia grow rapidly on formulated feeds with lower protein levels and tolerate higher carbohydrate levels than many carnivorous farmed species. They can also accept feeds with a higher percentage of plant proteins. It is easy to breed tilapia and culture them intensively and economically. (Chakraborty S.K. & Gupta M.V., 2005) They are relatively resistant to poor water quality.

In India, tilapia was introduced in 1952, with a view to filling up unoccupied niches, such as ponds and reservoirs. The species spread all across the country within a few years due to its prolific breeding and adaptability to a wide range of environmental conditions (Pandey P. K & Pandey A.K.,2007). In 2005, River Yamuna harbored only a negligible quantity of Nile tilapia, but in two years time, its proportion has increased to about 3.5% of total fish species in the river. Presently in the Ganges River system, the proportion of tilapia is about 7% of the total fish species. Nile tilapia (Oreochromis niloticus) is one of the most common fish species found in the freshwater lakes of Hyderabad. (Khaja S.B., Ravi R. & Kumar K.A.,2018).

Fish, being highly sensitive to changes in water quality, have been extensively used as biomonitoring organisms in ecotoxicological studies (Jain N. & Jain R.,2016). Hematological parameters of fishes have long been used as measures to assess the pollution levels of water bodies. (Khan A. R. & Anjum A.,2015 Khaleel K. M. & Reddy P. R.,2016)

These parameters include the red blood cell count, white blood cell count, hemoglobin concentration, hematocrit, mean corpuscular volume, and mean corpuscular hemoglobin concentration. Exposure of fish to contaminated water can lead to changes in these parameters, (Reddy M.P. & Sudhakar M.,2011, Padmavathi P. Swamy P. N.,2012, Singh D. Singh, R. Sharma B. M. & Khanna D. R.,2005) which can affect their physiological processes and overall health. Studies conducted in different parts of the world have reported changes in hematological parameters of fish due to water pollution.(Kumar A. Kumar S. & Kaushik G.,2013)Studiesconducted in India Reported that exposure of Indian major carp to hexavalent chromium led to a significant decrease in the red blood cell count, white blood cell count, and hemoglobin concentration.

Urban lakes are important water resources that support various human activities, including fishing, recreation as well as irrigation (Nagraj, N., & Murthy, K. N.,2013). The contamination of lakes with toxic chemicals as well as organic pollutants presents a threat to the health of fish living in the lakes. (Chen L. Wu L. & Liu G.,2016). Nile tilapia (Oreochromis niloticus) is one of the most common fish species found in the freshwater lakes of Hyderabad. In this study, the Nile tilapia samples were collected from five different lakes in Hyderabad city. The water quality parameters of these lakes were also analyzed to determine the level of contamination.

2. METHODOLOGY

In summary, the methodology of the study involved collecting fish samples, analyzing their hematological parameters, physicochemical parameters of water samples, conducting statistical analysis, and interpreting the data obtained

A) Study area description

The study was conducted in five lakes of Hyderabad city: Himayat Sagar, Osman Sagar, Mir Alam Tank, Shamirpet Lake, and Saroornagar Lake.

B)Water quality data procurement

The lake data has been procured from state pollution control board for a period of seven years and several water quality parameters were compared such as Dissolved Oxygen (DO), pH, Conductivity,

Biological Oxygen Demand (BOD), Nitrates, Fecal Coliforms, Chemical Oxygen Demand (COD), Chlorides, Sulphate, Total Dissolved Solids(TDS), Sodium, Calcium, Alkalinity, Magnesium & Hardness.

C) Haematological Analysis

Nile tilapia fish is procured from each of the five lakes for hematological analysis . Himayat Sagar Lake, Osman Sagar Lake, Shamirpet Lake, Saroornagar Lake and Mir Alam Tank. Samples were collected from different locations in each lake. Hematological parameters of the fish were analyzed using standard laboratory procedures. Samples of Oreochromis niloticus were collected using fishing nets biweekly from January to March 2023. Ten samples were collected from each lake and transported to the laboratory in an ice box for measuring Hematological values. Control fish samples were taken from a fish farm where tilapia is cultured under controlled environments to provide optimum growth. The blood samples were collected from the caudal vein of the fish by injecting a 2mm needle in less than 3 minutes to reduce handling stress. and placed in ethylene-diamine-tetra-acetic-acid (EDTA) treated bottles to prevent coagulation. After the collection blood samples were taken to the laboratory at the same day for assessment of hematological parameters. The analysis was conducted using standard hematological procedures using the fully automatic hematological analyzer.

Fig 1: Collection of fishes from the lakes

Fig 2: Collection of blood samples from *Oreochromis niloticus*

D) Data Analysis

Statistical analysis: The data obtained from the hematological and water quality analysis were statistically analyzed using one-way ANOVA and Tukey's post hoc test to determine the significant differences between the different locations. Statistical analysis was performed to determine the significant differences between the hematological parameters of the fish from different lakes.

3. RESULTS

Results of water quality analysis from 2016 to 2022 is given in the Table- 3 below .Water quality index calculation is done using an average of seven years taken for different parameters for each water body .

Calculation of Water Quality Index (WQI)

WQI is a ranking reflecting the cumulative effect on the total quality of water of various water quality parameters. Water quality information can be shown in a single value using WQI. WQI is generally used for identification and assessment of water pollution. In this study the Water Quality Index was calculated for parameters viz: DO, pH, Conductivity, BOD, Nitrate, Total Coliform, Fecal Coliform, COD, Chloride, Sulphate, TDS, Sodium, Calcium, Magnesium, Alkalinity and Hardness.

The estimation of WQI was carried out by Horton's method in this work. Using the following expression, the WQI is calculated.

$WQI = \Sigma qn\ Wn / \Sigma\ Wn$ (1)

Where qn = quality rating of n^{th} water quality parameter

Wn= unit weight of n^{th} water quality parameter

Quality rating (qn)

The rating of quality is calculated using the expression provided by

$qn = (Vn-V_{id})/ (Sn-V_{id}) \times 100$ (2)

Where V_{id}= ideal value (for pH = 7 and for other values it is zero and for DO it is 14.6)

Sn = Acceptable limit as given in BIS 2012 standards

Vn= estimated chemical value of sample

Unit Weight (Wn)

In the first step weights are assigned from 1-5 for the designated water quality parameters (DO, pH, Conductivity, BOD, Nitrate, Total Coliform, Fecal Coliform, COD, Chloride, Sulphate, TDS, Sodium, Calcium, Magnesium, Alkalinity and Hardness), depending on parameters relative value in terms of overall water quality for drinking purposes. Depending on the water quality criteria the more significant parameter is assigned with the weightage of 5 and the less significant parameter is given the weightage of 2 .

In the next step calculate the Unit weight (Wn) for each chemical parameter using the below equation

$Wn = wi / \Sigma wi$ (3)

Where Wn is unit weight of parameter

The following Table 1 shows the Weight and Unit Weight of water quality Parameters considered for this study.

Table 1. Weight and Unit Weight of water quality Parameters

S.No	Parameter	Desirable Limit - BIS/WHO/ICMR	Weight (wi)	Unit Weight Wn = wi / Σwi
1.	**DO (mg/L)**	5	5	0.09
2.	**pH**	6.5 - 8.5	4	0.07
3.	**Conductivity (µs/cm)**	700	4	0.07
4.	**BOD (mg/L)**	5	5	0.09
5.	**Nitrate (mg/L)**	45	5	0.09
6.	**Total Coliform (MPN/100 ml)**	Absent	5	0.09
7.	**Fecal Coliform (MPN/100 ml)**	Absent	5	0.09
8.	**COD (mg/L)**	20	2	0.03
9.	**Chloride (mg/L)**	250	3	0.05
10.	**Sulfate (mg/L)**	200	4	0.07
11.	**TDS (mg/L)**	500	5	0.09
12.	**Sodium (mg/L)**	200	2	0.03
13.	**Calcium (mg/l)**	75	2	0.03
14.	**Magnesium (mg/L)**	30	2	0.03
15.	**Alkalinity (mg/L)**	200	3	0.05
16.	**Hardness (mg/L)**	200	2	0.03
			Σwi = 58	**ΣWn = 1**

Table 2. Water Quality Rating as per Weighted Arithmetic Water Quality Index Method

WQI Value	Rating of Water Quality	Grading
0-25	Excellent	A

26-50	Good	B
51-75	Poor	C
76-100	Very Poor	D
Above 100	Unsuitable for Drinking	E

Fig 3: WQI of five different lakes

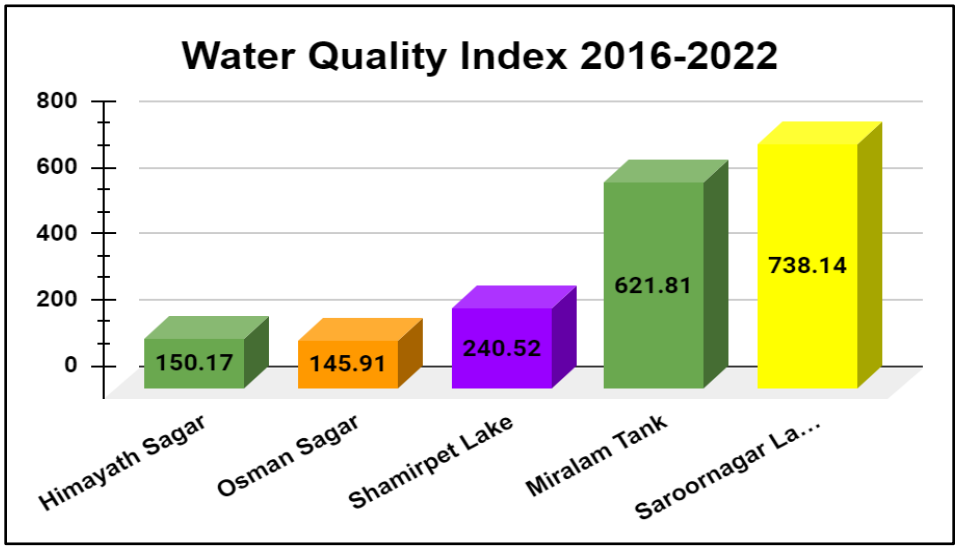


Table 3: Average WQI of five different lakes for a period of seven years

Sl. No	**Lake**	**WQI - (2016-2022)**
1	**Himayat Sagar**	150.17
2	**Osman Sagar**	145.91
3	**Shamirpet Lake**	240.52
4	**Mir Alam Tank**	621.81

5	**Saroornagar Lake**	738.14

Water quality analysis of the five water bodies showed deteriorated water quality unsuitable for drinking purposes .Blood analysis results showed significant variations in the hematological parameters of Nile tilapia from different locations in each lake. The fish from the highly contaminated lakes had lower hemoglobin concentration, red blood cell count, and hematocrit compared to those from less contaminated areas. The mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration were also significantly affected by the water contamination. The physicochemical analysis of the water samples revealed high levels of different kinds of pollutants in contaminated areas.Findings of present study coincide with previous studies (Ghani N.A., A.RahmanM.A., & Ibrahim M.K., 2014).

Our results showed significant differences in the hematological parameters of Nile tilapia from five different lakes . These results clearly indicate the water quality deterioration in different lakes significantly affected the hematological parameters of Nile tilapia. The levels of red blood cells (RBCs), hemoglobin (Hb), and hematocrit (Hct) were significantly lower in fish from contaminated lakes compared to those from the control(where optimum conditions are maintained).This indicates that the fish from contaminated lakes are suffering from anemia, which is a common symptom of exposure to toxic substances.

In addition, the levels of white blood cells (WBCs) were significantly higher in fish from contaminated lakes compared to those from the control lake. This indicates that the fish are undergoing immune responses to the toxic substances in the water.

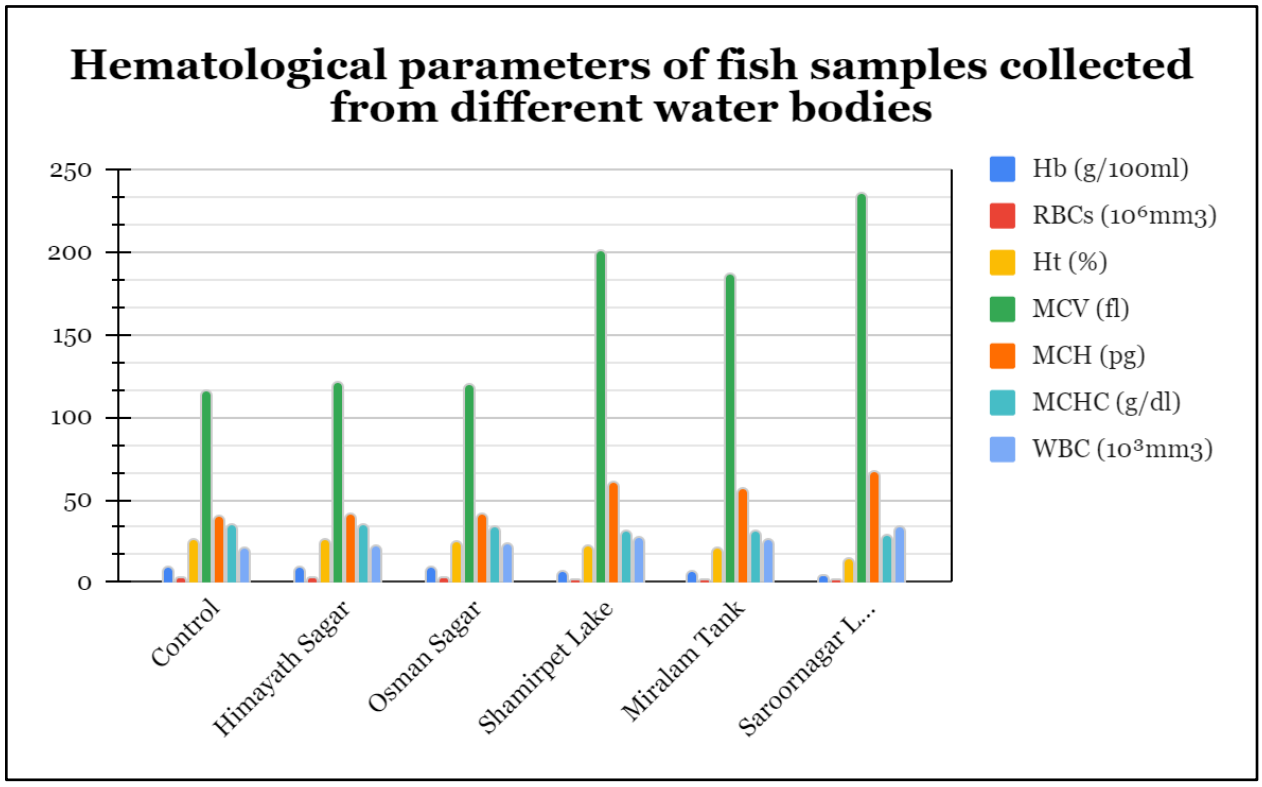
The water quality analysis revealed that the lakes in Hyderabad city were contaminated with various pollutants such as heavy metals, organic compounds, and pesticides. The levels of these contaminants were significantly higher in the contaminated lakes compared to the control lake. The levels of dissolved oxygen, pH, and BOD were also significantly different between the lakes, indicating variations in water quality.

Table 4. Hematological parameters of Nile tilapia (*Oreochromis niloticus*)samples collected from different lakes of Hyderabad.

Hematological parameters	Unit	Control	Himayat Sagar	Osman Sagar	Shamirpet Lake	Mir Alam Tank	Saroornagar Lake
Red blood cells (RBCs)	10^6mm3	2.26 ± 0.20	2.26 ± 0.20	2.09 ± 0.15	1.08 ± 0.10	1.12 ± 0.13	0.61 ± 0.10
Hemoglobin(Hb)	g/100ml	9.12 ±0.43	8.55 ± 0.84	8.37 ± 0.54	6.61 ± 0.45	6.31 ± 0.57	4/04 ± 0.66
Hematocrit (Ht)	(%)	26 ± 1.14	25.16±2.44	24.66 ± 1.80	21.69±2.18	20.66±2.36	14.12±1.96
Mean corpuscular hemoglobin (MCH)	(pg)	40.07±2.29	40.74±1.08	40.57±3.32	60.54±2.80	56.74±4.71	66.79±3.57
Mean corpuscular volume (MCV)	(fl)	115.34±7.43	120.06±5.20	119.88±9.80	200.29±13.60	185.91±16.97	235.42±22.45
Mean corpuscular hemoglobin concentration (MCHC)	g/dl	35.05±1.16	33.98±1.24	33.60±1.14	30.38±1.37	30.62±1.09	28.62±2.13
White blood cells (WBCs)	10^3 mm3	20.24±1.93	22.68±2.21	22.39±3.14	26.62±1.81	33.46±4.67	25.16±1.24

Each value is a means ± standard error.shows statistically significant difference (P<.001)

Fig 4: Hematological parameters of fish samples collected from different water bodies



Hemoglobin(g/dl)

Interpretation: A one way analysis of ANOVA was done to compare the mean Hb values of Nile tilapia fish in various lakes of Hyderabad. There was a significant difference in mean Hb between the groups. Further Tukey's post hoc analysis revealed that the mean Hb of the fish in the lakes of control, Himayat and Osman Sagar were comparable to each other but were significantly greater than that of Mir Alam Tank, Shamirpet and Saroornagar Lake. Mir Alam and Shamirpet though had comparable mean hb which were significantly different from Saroornagar respectively.

The pathophysiology of polycythemia varies based on its cause. The production of red blood cells (erythropoiesis) in the body is regulated by erythropoietin, which is a protein produced by the kidneys in response to poor oxygen delivery.

Red Blood Cell (10^6 µ/l)

Interpretation: A one way analysis of ANOVA was done to compare the mean RBCvalues of Nile tilapia fish in various lakes of Hyderabad. There was a significant difference in mean RBC between the groups. Further Games Howell Post hoc analysis revealed that the mean RBC of the fish in the lakes of control, Himayat and Osman Sagar were comparable to each other but were significantly greater than that of Mir Alam Tank,Shamirpet and Saroornagar Lake. Mir Alam and Shamirpet though had comparable mean RBC which were significantly different from Saroornagar.

Hematocrit(%)

Interpretation: A one way analysis of ANOVA was done to compare the mean HCT values of Nile tilapia fish in various lakes of Hyderabad. There was a significant difference in mean HCT between

the groups. Further Tukey's post hoc analysis revealed that the mean HCTof the fish in the lakes of control, Himayat Sagar, Osman Sagar, Mir Alam Tank and Shamirpet Lake, were comparable to each other but were significantly greater than that of Saroornagar Lake respectively.

Mean Corpuscular Volume(fl)

Interpretation: A one way analysis of ANOVA was done to compare the mean MCV values of Nile tilapia fish in various lakes of Hyderabad. There was a significant difference in mean MCVbetween the groups. Further Tukey's post hoc analysis revealed that the mean MCVof the fish in the control was significantly lower than that of all the other lakes. Himayat and Osman SagarMCVwere comparable but were significantly lesser than that of Mir Alam Tank and Shamirpet which were comparable to each other but were significantly lesser than that of Saroornagar Lake respectively.

Mean Corpuscular Hemoglobin(g/dl)

Interpretation: A one way analysis of ANOVA was done to compare the mean mch values of Nile tilapia fish in various lakes of Hyderabad. There was a significant difference in meanMCH between the groups. Further Tukey's post hoc analysis revealed that the mean MCH of the fish in the lakes of control, Himayat Sagar ,Osman Sagar were comparable to each other and were significantly lesser than that of Mir Alam Tank and Shamirpet were comparable to each other but were significantly lesser than that of Saroornagar Lake respectively.

Mean Corpuscular Hemoglobin(g/dl) Concentration

Interpretation: A one way analysis of ANOVA was done to compare the mean Mean Corpuscular Haemoglobin Concentration Values of Nile tilapia fish in various lakes of Hyderabad. There was a significant difference in mea MCHC between the groups. Further Tukey's post hoc analysis revealed that the mean MCHC of the fish in the lakes of control, Himayat Sagar ,Osman Sagar were comparable to each other and were significantly greater than that of Mir Alam Tank and Shamirpet and Saroornagar, respectively.

White Blood Cells(10^3 µ/l)

Interpretation: A one way analysis of ANOVA was done to compare the mean WBC values of Nile tilapia fish in various lakes of Hyderabad. There was a significant difference in mean WBC between the groups. Further Games Howell post hoc analysis revealed that the mean wbc of the fish in the lakes of control was significantly lower than that of Himayat, Osman Sagar, Mir Alam Tank and Shamirpet which were comparable to each other although they were significantly lesser than that of Saroornagar respectively.

4. DISCUSSIONS

The hematological parameters of fish have long served as a proxy measure of water contamination.Our findings suggest that water contamination has a significant impact on the hematological parameters of Nile tilapia.The significant differences in hematological parameters observed in fish from different lakes indicate that the level of contamination varies across different lakes in Hyderabad The significant variations observed in the hematological parameters of Nile tilapia from different locations in each lake indicate that water contamination has a negative effect on the fish's health. The lower hemoglobin concentration, red blood cell count, and hematocrit in the highly contaminated areas could be due to the toxic effect of heavy metals present in the water. The mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration were also significantly affected, which indicates the possible presence of anemia in the fish.

The specific contaminants responsible for the observed changes in hematological parameters were not investigated in this study. However, previous studies have reported that heavy metals, organic pollutants, and other toxic chemicals can cause changes in hematological parameters of fish.

5. CONCLUSION

This study highlights the adverse effect of lake water contamination on the hematological parameters of Nile tilapia from different locations in Hyderabad city. The significant variations observed in the hematological parameters indicate that water contamination has a negative effect on the fish health. The high levels of non biodegradable contaminants as well as organic matter in the highly contaminated areas could be a major factor affecting the fish health. Thus, the need for regular monitoring of water quality and taking appropriate measures to reduce water pollution is essential to ensure the sustainability of aquatic ecosystems and the health of aquatic organisms. In conclusion, our study highlights the impact of lake water contamination on the hematological parameters of Nile tilapia from different places in Hyderabad. The results of this study suggest that water pollution is a significant threat to the health of fish in Hyderabad lakes. The identification of specific contaminants responsible for the observed changes in hematological parameters can help in the development of effective strategies to mitigate the impact of water pollution on aquatic life.

The results indicate that the fish are suffering from anemia, immune responses, and metabolic dysfunction due to exposure to toxic substances in the water. The study highlights the importance of regular monitoring of water quality in lakes to prevent contamination and protect the health of aquatic organisms.

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