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ACUTE TOXICITY STUDIES OF TEXTILE BASED INDUSTRIAL EFFLUENT OF PALI CITY ON A FRESHWATER FISH

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Abstract

The LC50 values obtained after 12 hours, 24 hours, 48 hours, 72 hours, and 96 hours were 56.23 percent, 28.84 percent, 22.3 percent, and 16.59 percent, respectively. As effluent concentration increased, LC50 readings dropped noticeably. The calculated secure value is 32.88%. The C.batrachus fishes used in the experiments displayed more anxious behavior as the toxicant concentrations rose. High mucus production, uncoordinated and tailfin movement, surfacing, loss of buoyancy, escape propensity, hyperactivity, and skin discoloration were all seen in experimental C. batrachus fish exposed to textile-based industrial effluent. All therapies, save the control group, had fatality rates. Experimental fish C.batrachus treated to textile-dyeing effluents for varying lengths of time also underwent haematological investigation. The hemogram, red blood cell count, white blood cell count, platelet count, mean corpuscular volume, mean corpuscular hemoglobin concentration, and mean corpuscular hemoglobin concentration of the test species were analyzed. Modifications to these settings have been discussed. It follows that the TIE is harmful to fish and other aquatic life.

Key words: Textile effluents Haematology Acute toxicity Clarias batrachus (L.)

INTRODUCTION

Human activity has a negative impact on aquatic ecosystems by altering the quality of their water (Makwana 2020a). In addition to this, the textile industry and the waste it produces contribute significantly to global pollution. Organic compounds, dissolved dyes, and poisonous substances are the principal sources of pollution in textile effluent. All of the processes—printing, scouring, bleaching, and dying—contribute chemicals to the effluent (Deepali & Gangwar 2010). The many kinds of dyes and pigments used in textile operations including dying and printing have been discussed by Berardi et al. (2019).

The textile printing and dying businesses make up the bulk of Pali city's industrial district. Toxic textile effluents are released by these factories (Satish et al. 2008). Pali's textile and dyeing businesses discharge wastewater without sufficient treatment, degrading the quality of groundwater and the water supply in the region. Discharges of textile effluents into the Bandi River in Pali city are very hazardous, reducing the overall quality of the river water and having devastating effects on the river's aquatic life (Makwana 2020b). Results show that river water's pH is over the safe range, and that other metrics, such as biological oxygen demand and total hardness, are also elevated. The concentrations of total dissolvable solids (TDS), chloride, and sulphate in the output sample are higher than those in the intake sample. According to Holkar et alhypothesis, .'s the primary contaminants in wastewater are those discharged at the beginning, middle, and end of the textile wet process (2016). Yaseen and Scholz (2016) state that textile dye effluents are often quite black in color, and have elevated levels of pH, suspended particles, chemical oxygen demand, and biochemical oxygen demand.

Liquid waste has increased significantly as a consequence of rapid industrialization in India, and this has led to a variety of environmental issues including surface water logging, ground water pollution, and salinization of excellent grade soil as a result of the presence of high quality salts (Ramona et al.2001). Effluent discharge into freshwater systems reduces the amount of oxygen in the water, which in turn disrupts respiratory metabolism and leads to high mortality (Quasim and Siddque, 1960; David and Ray, 1966; Venkataraman, 1966; Hingoroni et al.1979). A significant factor in the widespread extinction of fish and other vital aquatic biota is the pollution of aquatic systems by human waste and untreated or poorly treated industrial effluent (Kumari and RamKumari, 1997).

The acute toxicity test provides the groundwork for learning about the detrimental effects of chemicals and metals on living things. After the introduction of water pollution management laws, the median tolerance limit, or LC50 as it is now often known, was validated as a valid metric for the formulation of water quality requirements. Most ecotoxicological investigations have used fish as their primary test organism because of their ability to withstand repeated exposure to toxins over long periods of time. Fishes are often used because of their availability, ease of handling in the lab, and the broad range of toxicity levels they exhibit [13]. Significant emphasis has been placed on lethality during fish bioassay. Fish may not die from exposure to low levels of pollution, but they may suffer non-lethal toxicity. There have been a number of attempts to measure the toxicity of contaminants to aquatic biota, particularly fishes. The marine catfish Arius nenga (Hamilton, 1822), a popular food fish in Kerala, was chosen for this investigation. The goal of this research was to examine the toxicity of various quantities of industrial effluent that flows directly into the coastal area of Kollam, South West Coast of Kerala, and to calculate the acute toxicity of A. nenga over the course of 24 hours.

Behavior changes in Cyprinus carpio were seen after exposure to dairy effluent (Amutha et al.1999). Effects of Sago wastewater on the freshwater fish Catlacatla were observed by Nagarajan & Ramesh (2001). When the fish Labeo rohita was subjected to wastewater from the sago industry, comparable results were seen, as reported by Nagarajan & Shasikumar (2002). The impacts of the tannery effluent on the freshwater fish Catlacatla have been described by Shanthi (2003). The fish Catlacatla have been shown to be hazardous to dyeing wastewater, as noted by Nagarajan & Boopathi Raja (2004). Nagarajan and Suresh (2005) found similar results while studying the fish Cirrhinus mrigala in sago effluent. The effects of distillery effluent on the fish Labeo rohita were examined by Nagarajan &Aruna(2006).

Bioassays have been used extensively for the monitoring and assessment of home and industrial wastewater toxicity (Hader 2018). Soni et al. conducted a bioassay to determine the acute toxicity of pretilachlor (an herbicide) in the fish Clarias batrachus using the probit analysis approach (2018). The 96-hour LC50 value for lead acetate in the fish Oreochromis mossambicus was calculated by Arya et al. (2018). Values were determined using probit analysis after the acute toxicity test was conducted using APHA-recommended procedures. Oreochromis mossambicus exposed to textile effluent had its haematological parameters measured by Amte et al (2013). Haematological characteristics of the freshwater catfish Heteropneustes fossilis were examined by Srivastav & Dayalanand (2015). Vital to understanding fish health and physiology are haematological markers.

The purpose of this research was to examine the acute toxicity of textile effluent on the fish Clarias batrachus and the influence of the effluent on the fish's behavioral response.

LITERATURE REVIEW

Kaur, N., Brraich, O.S. (2022), Wetlands and aquatic ecosystems as a whole are under severe threat from pollution in the modern period. Solid, liquid, and gaseous wastes are produced in great quantities not just because of the greater population density in urban areas, but also because of the high-tech enterprises that serve them. Toxic compounds included in industrial effluent wastes may have an effect on aquatic life throughout the discharge process, posing a threat to both aquatic life and human health. This research aimed to estimate the nutritional value of fish liver and intestine, both of which are typically thrown away as waste during fish processing, and to assess the pollution status of both wetlands through the year by calculating the water quality index (WQI) and comparing them across different seasons. Harike Wetland's Water Quality Index was found to be 56.68, which is considered "bad" water quality; in contrast, Nangal Wetland's WQI was found to be 39.54, which is considered "excellent" water quality and safe for the whole ecosystem. The heavy metal pollution index (HPI) of 144.9 was measured in the Harike Wetland, while the HPI of 3.12 was measured in the Nangal Wetland, both of which indicate a high concentration of heavy metals in the sample environment. The metal index (MI) value at the test sample location was likewise found to be higher (4.76). (0.22). Liver samples from test fish (Harike Wetland) had lower mean total n-3 and n-6 polyunsaturated fatty acids (PUFAs) compared to control fish (Nangal Wetland) samples, with the exception of the winter. As with total omega-3 fatty acids, mean total saturated fatty acids (SFAs) in the liver of test fish samples were shown to decrease considerably (p0.05) when compared to control fish samples over fall and winter. When comparing test fish to control fish throughout all four seasons, we found that the mean total n-3 PUFAs (except winter) and total n-6 PUFAs (except rainy) in the gut of test fish decreased significantly (p0.05). Test fish samples had higher levels of total SFAs in their intestines compared to control fish samples throughout all seasons.

R. Kaur & A. Dua (2015), The purpose of the research was to compare the behavioral, morphological, and histological biomarkers of fish exposed to wastewater from sites 1 and 2 of the Tung Dhab drain in the Indian state of Punjab with those of a control group. For both locations, LC50 was determined by subjecting the effluent to five different concentrations (range: 6.25%-100%). Variations in fish behavior and appearance were closely monitored. Sewage chemistry and physics were analyzed according to APHA/AWWA/WEF guidelines (2005). Sublethal amounts of wastewater (50-90% of LC50) were used in 15- and 30-day chronic toxicity studies, and gill histology was evaluated. The LC50 results near a paper mill showed that the water there was 72.45% more hazardous than water farther away. The values observed for certain measures were greater than the prescribed discharge limits, indicating a clear decline in water quality. The longer the test fish were exposed to the chemicals, the more they surfaced for air, moved in a haphazard manner, and gulped it in rapidly. Changes in appearance include discoloration, mucus production, scale loss, and bruises on the skin and lower lip. Gill histology in the experimental fish was shown to be altered, with features such as lamellar fusion, epithelial lifting, oedema, hemorrhages, necrosis, and aneurysms. The results suggest that after 15 and 30 days, the gill organ index (IG) of fish exposed to wastewater from both locations was considerably higher than that of control fish.

Kafaiat Allah Bawa (2022), Pollutants in aquatic environments often come from point source wastewater discharges from industry. The toxicity of effluents from the paint industry was evaluated using a full effluent testing technique in this research. Three paint factories' effluents were collected just before they were released into the environment. The fish toxicity of the effluents was determined using bioassay techniques. The 96-hour LC50 value for Effluent B was 3.50 percent (v/v), making it the most intensely hazardous to the fish. Effluents were ranked according to their acute toxicity to fish, with B being the least toxic and A being the most hazardous. Fish exposed to sublethal concentrations of the effluents had their liver function enzyme and oxidative stress enzyme activity considerably (p 0.05) increased, according to an analysis of biochemical markers. Oxidative stress substrate malondialdehyde was also substantially (p 0.05) increased in fish exposed to the effluents, with levels of 3.87 0.40, 4.99 0.45, and 3.22 0.57 U mg-1 protein for effluents A, B, and C, respectively, compared to control (1.24 0.31 U mg-1 protein). Based on the findings of this research, it is clear that effluents from the paint industry, whether untreated or poorly treated, may be very harmful to aquatic life. The benefits of whole effluent testing as a means of correctly predicting the hazardous potentials of industrial effluents are highlighted in the research. This is crucial for providing sufficient safety for aquatic habitats.

Eka B. Essien* Bene W. Abbey Nwosu Chinwe (2015), Tilapia (Oreochromis niloticus) was used to test the toxicity of the mixed effluent (industrial, household, and municipal) discharged into Okrika River. A control sample of Tilapia was taken from a fish pond associated with the Rivers State Sustainable Development Authority (RSSDA), and samples taken downstream and upstream from the site of entrance of mixed effluent into the River. The liver homogenate was tested for malondialdehyde (MDA) content and glutathione S-transferase (GST) activity. Serum from the fishes was tested for the presence of the enzymes alanine amino transferase (ALT), alanine aspartate transferase (AST), and alkaline phosphatase (ALP). We also analyzed a liver tissue segment that had been histopathologically processed. There was no discernible shift in upstream liver MDA levels, while the concentration of MDA in the liver rose considerably (p0.05) from 2.45 0.77 to 6.09 1.57nm/mg tissue in the downstream samples. Upstream Hepatic GST was considerably decreased from 5.59 1.09 to 3.65 1.48 IU/L compared with the control, whereas downstream Hepatic GST was dramatically raised from 5.59 1.09 to 16.80 0.71 IU/L. Serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alanine aminopeptidase (ALP) activity were all significantly higher in the exposed fish compared to the control group (P 0.05; ALT: 99.8 3.5 IU/L; AST: 277.02 39.8 IU/L; ALP: 40.38 11.4 IU/L; ALP: 15. Vacuolar degeneration, isolated regions of necrosis, and aggregation of inflammatory cells between the hepatocytes were seen on histological examination of the liver. Because of the presence of mixed effluent in the River, this research elucidates unfavorable biochemical alterations on the fish metabolism.

A. Bakshi (2018), Chrome may exist in one of three oxidation states: Cr (II), Cr (III), or Cr (VI). And among these, Cr (II) is the most prone to rapid decay. Chromium is often found in the environment in its stable oxidation states, Cr (III) and Cr (VI). Chromium and its particles reach the aquatic medium through effluents released from a variety of industries including the textile, tannery, electroplating workshop, mineral mining, dyeing, printing-photographic, and medical sectors. Hexavalent chromium is the most dangerous because it easily crosses cell membranes and is converted to the less harmful trivalent version once within the cell. Toxic and mutagenic modifications caused by chromium bind to a variety of macromolecules, including DNA, in the cytosol. Chromium may be absorbed by the body via the digestive system or the lungs. The quantity is conditional on the nature of the chromium and the medium in which it is to be used. This review makes an effort to compile the vast amount of information on chromium's effect on fresh water fishes into a logical whole. The primary aim of this evaluation is to serve as a future guideline for the scientific community and public authorities engaged in health risk assessment and management, with the ultimate goal of improving environmental conditions for human health.

MATERIALS AND METHODS

Collection and Acclimatization of the Experimental Fish

Fish of the species Clarias batrachus were caught in their natural habitat and brought to the lab in huge aerated polythene bags holding water from the spot where they were caught. A huge glass aquarium with fish in good health was set up. The fish were given a bath in a KMnO4 solution with a 0.1% concentration before the experiment, to prevent any skin infections.

Before being employed in the bioassay testing, the fish were acclimated to the laboratory environment for two weeks. Every 48 hours, the water was changed to get rid of fish waste and increase the oxygen levels. The protein food was used for the acclimation period when the fish were being kept in their tank. Before the experiment, the fish fasted for 24 hours. This experiment followed the APHA-recommended protocol for assessing the acute toxicity of contaminants to fish.

Acute Toxicity Bioassay and Statistical Analysis of Data

The textile effluents were utilized in six different concentrations, ranging from 0% (control) to 30% (low concentration) to 70% (high concentration). Effluent from the textile industry was not contained in the control group. The death rate of ten young fish was calculated at 24, 48, 72, and 96 hours. To avoid contaminating the water supply, the dead fish were quickly removed. With a probit analysis plotting probit mortality against log concentration, the LC50 over 24, 48, 72, and 96 hours was calculated. Using probit 5, we projected the LC50 value to the log concentration. When converted to a percentage, the antilog numbers reveal the LC50. Finney's Table was used to get the probit values for the percentage mortality rate (Finney 1971).

LC50 values were calculated based on mortality data collected at 24, 48, 72, and 96 hours. Observations of morphological and behavioral indicators were made to document the toxicity of textile wastewater. The frequency of monitoring for both the control and textile effluent-treated groups of fish was determined by repeated measurements at regular intervals.

RESULTS AND DISCUSSION

Lethal Toxicity Test

Table 6 displays the calculated LC50 values for a variety of textile effluent concentrations along with 95% confidence intervals. Exposure duration had a statistically significant effect on LC50 values (p 0.05). The median lethal concentration (LC50) drops with increasing exposure duration.

In Fig.1, we see textile wastewater being discharged into the Bandi River, which is located close to the Pali Industrial Area. A broad range of concentrations of textile industrial effluent (TIE) exposed C. batrachus to variable degrees of death (Table 1). Tables 1–5 and Figures 1–5 show how the proportion of deaths grew dramatically as the quantity of the toxicant and the length of the experiment increased, respectively.

Table 1: Mortality rate of Clarias batrachus exposed to different concentrations of the effluent.

Mortality Percentage									
Concentration v/v)	%(No.offish	24hrs		48hrs		72hrs		96hrs	
		M	M%	M	M%	M	M%	M	M%
Control	10	0	0	0	0	0	0	0	0
10 %	10	0	0	1	10	2	20	3	30
30 %	10	2	20	3	30	5	50	7	70
50 %	10	3	30	5	50	7	70	9	90
70 %	10	6	60	10	100	-	-	-	-

Table 2: Log concentrations and probit values when exposed to textile effluent after 24 h

S.No.	Conc. % (v/v) 24 hrs	Log Conc.	No. ofFish	24hrs	
				Mortality %	Probit
1	Control	0	10	0	0
2	10 %	1.0000	10	0	0
3	30 %	1.4771	10	20	4.1
4	50 %	1.6989	10	30	4.48
5	70 %	1.8450	10	60	5.25

Table 3: Log concentrations and probit values when the fish exposed to textile effluent after 48 h

S.No.	Conc. % (v/v) 48 hrs	Log Conc.	No. ofFish	48hrs	
				Mortality %	Probit
1	Control	0	10	0	0
2	10 %	1.0000	10	10	3.72
3	30 %	1.4771	10	30	4.48
4	50 %	1.6989	10	50	5
5	70 %	1.8450	10	100	7.37

Table 4: Log concentrations and probit values when the fish exposed to textile effluent after 72 h

S.No.	Conc. % (v/v) 72 hrs	Log Conc.	No. ofFish	72hrs	
				Mortality %	Probit
1	Control	0	10	0	0
2	10 %	1.0000	10	20	4.1
3	30 %	1.4771	10	50	5
4	50 %	1.6989	10	70	5.52
5	70 %	1.8450	10	100	7.37

Table 5: Log concentrations and probit values when the fish exposed to textile effluent after 96 h

S.No.	Conc. % (v/v) 96 hrs	Log Conc.	No. ofFish	96hrs	
				Mortality %	Probit
1	Control	0	10	0	0
2	10 %	1.0000	10	30	4.48
3	30 %	1.4771	10	70	5.52
4	50 %	1.6989	10	90	6.28
5	70 %	1.8450	10	100	7.37

Fig. 1: Flow of textile effluents into Bandi River near Pali industrial area

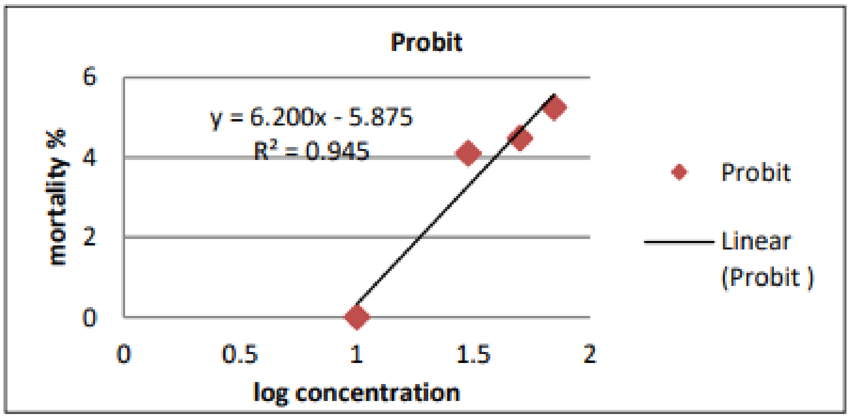

Fig. 2: Linear regression curve of log concentration and mortality response of C.batrachus after 24 hrs. exposure to textile effluent.

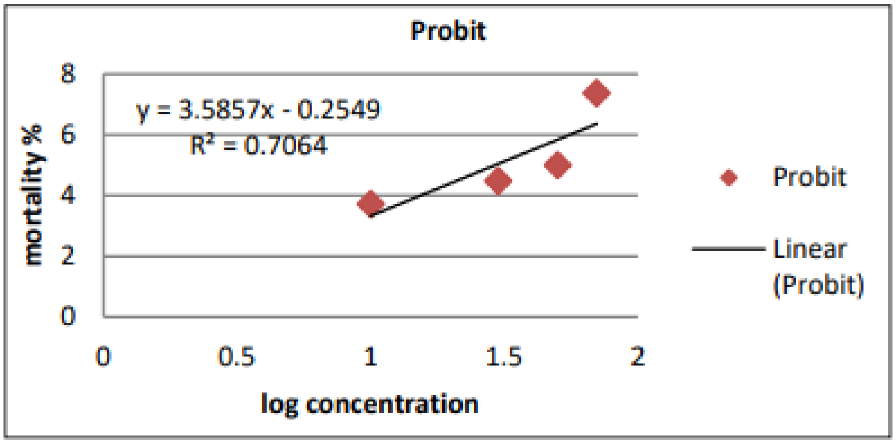

Fig. 3: Linear regression curve of log concentration and mortality response of C.batrachus after 48 hrs exposure to textile effluent.

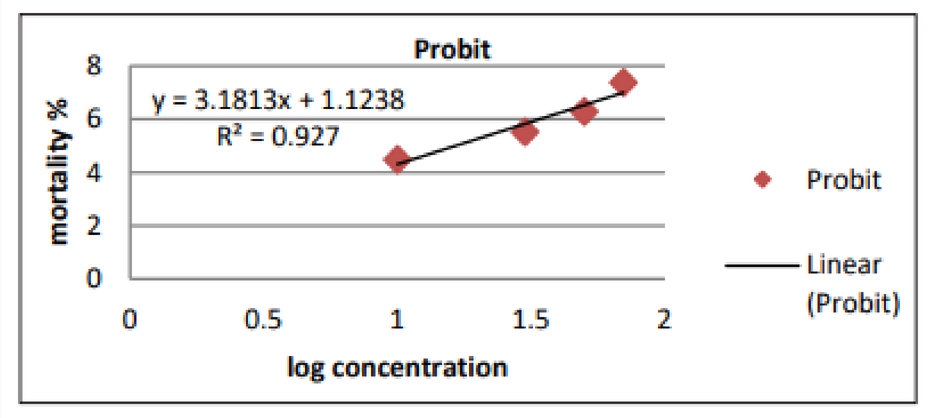

Fig. 4: Linear regression curve of log concentration and mortality response of C.batrachus after 72 hrs exposure to textile effluent.

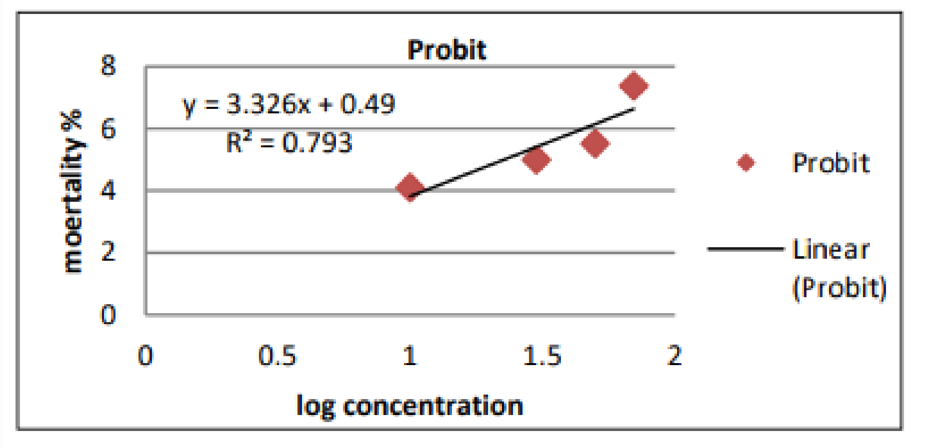

Fig. 5: Linear regression curve of log concentration and mortalityresponse of C.batrachus after 96 hrs exposure to textile effluent.

The fish in the control group showed no signs of death. Mortality rates ranging from 10% to 70% were observed in the experimental group of fish at 24, 48, 72, and 96 hours (Table 6). Results for LC50 were summarized in Table 6; they were 56.23 percent at 24 hours, 28.84 percent at 48 hours, 22.3 percent at 72 hours, and 16.59 percent at 96 hours. Based on these findings, it can be concluded that effluent is very hazardous wastewater to fishes, namely Clarias batrachus.

A technique similar to that published by Hart et al. was used to determine the maximum allowable concentration of hazardous textile effluent that might be ingested by the fish Clarias batrachus (1945). A concentration of 32.88% was determined to be safe (Table 6). The fatal toxicity test found that all treatment doses resulted in fish deaths, but the control tank fish all survived. We drew lines between the log concentration (mortality percentage) and the probit value after 24, 48, 72, and 96 hours of internal exposure (Figs.1, 2, 3 and 4). As the water's content of the poisonous substance rose, so did the number of deaths it caused. Other investigators have made a similar discovery, noticing that various fish species react differently to varying concentrations of toxicants (Agbon et al. 2002, Omoregie et al. 2009, Umar et al. 2010).

Some hypothesize that changes in water quality and the species used in the tests account for the observed difference in acute toxicity. Acute toxicity may vary from species to species and from one toxicant to another based on variables including body size, age of animals used in experiments, and other environmental conditions (Farah et al. 2004). Eaton & Gilbert reported the water's current physiological characteristics (2008). The findings show that the LC50 values of the different fish are directly affected by the high concentration of textile effluent including chemical dye, hazardous components, and heavy metals.

Table 6: Lethal concentrations of textile effluent at various exposure times for C. batrachus

S.No.	Time period	LC50 %	Regression line /slope	Coefficients	95% Confidence Interval		Safe concentration
					Lower Bound	Upper Bound	
1.	24 h	56.23	y = 6.200x - 5.875	6.1992 ±1.050	1.67725	10.72132	32.88 %
2.	48h	28.84	y = 3.585x - 0.254	3.5853±1.6343	-3.4468	10.6176	
3.	72 h	22.38	y = 3.181x + 1.123	3.3263±1.2012	-1.8422	8.4950	
4.	96h	16.59	y = 3.326x + 0.49	3.1810±0.6311	0.4654	5.8965	

CONCLUSION

This research was conducted to assess the acute toxicity and behavioral reactions of Clarias batrachus (Linnaeus) to textile manufacturing effluent. Exposure of fishes to industrial based textile effluent resulted in increased mortality, and this trend was more pronounced as effluent concentration rose. The results of this research show that exposure to textile effluent causes a variety of behavioral and morphological changes in fish, which may cause serious physiological difficulties and even death. This demonstrates the need for treatment of textile effluent before its release into Pali city's Bandi River.

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