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Toxicity of Textile Dyeing Effluent on Ethological Changes in the Common Carp *Cyprinus Carpio*

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ABSTRACT: *Cyprinus carpio* was employed to assess the behavioral and morphological changes when exposed to dyeing industry effluent. The 96h LC₅₀ range of dyeing industry effluent was and two sub lethal concentrations (6.875% and 6.25%) were selected. The various behavioral responses like erratic movements, gulping air on the surface or jumping out of water, opercular movements, loss of equilibrium, hitting against the wall, restlessness, sluggishness, fishes lied on the water surface before death and morphological changes like loosening of scales, redness in eyes, profuse mucous secretion, bleeding from gills, ballooning and belly upward, pigmented patches on the abdomen were observed. These responses and changes were more at higher concentration (6.875%) and duration of time (72h) as compared to other concentrations and time durations. Even lower concentrations can also exert changes in behaviour and morphology and cannot be ignored. Control fishes were also monitored to record the normal behaviour.

KEYWORDS: Behavioral Responses, Morphological Changes, Aquatic Pollution, Dyeing Industry Effluent, *Cyprinus carpio*

I.INTRODUCTION

Industries are among the most important point source of pollutants and discharge huge amount of waste substance into aquatic ecosystem. They can generate both organic and inorganic wastes, which could alter all or parts of biological, physical and chemical characteristics of the receiving water bodies [1]. Freshwater bodies such as rivers, lakes and ponds have actually become the disposal sites of domestic and industrial wastes.

Fish is a rich source of proteins which is good for human health. The toxic substances are accumulated in these polluted water bodies, consequence of which is gross pollution of water. In contaminated water, fish may exhibit morphological changes and behavioral responses which can be used as biomarkers of contamination.

Behaviour allows an organism to adjust to external and internal stimuli in order to meet the challenges of surviving in the changing environment whereas morphological changes are external changes caused due to changed environment. The use of these abnormalities in fish as biomarkers has become more prevalent in recent years. These biomarkers can provide suitable indication about the environmental condition.

The morphological and behavioral changes are the most straightforward methods to study the effects of contaminants on fish in aquatic ecosystem. The changes act as diagnostic endpoints in screening the effect of polluted water on fishes. The effluent of dyeing industry contains heavy metals and other poisonous substances. The pollutants in the water get incorporated into the fish [2] and via food chain reach the human body causing human afflictions. The main

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objectives of the present study were to determine the 72 hours and 96 hours LC₅₀ of dyeing industry effluent and to study behavioral and morphological changes in *Cyprinus carpio*.

II.MATERIALS AND METHOD

Freshwater fish, *Cyprinus carpio* measuring 7.0-8.5 cm in length and 6.0 – 9.0 gms in weight were collected from government fish seed farm, Patiala. Fishes were treated with 0.1% KMnO₄ solution for 30 minutes to remove any external infections and were acclimatized in laboratory for 20 days. They were starved for 24h prior to experimentation.

Textile dye effluent was collected at the discharge point in the river Cauvery at Komarapalayam (Namakkal District , Tamil Nadu, India) and transported to the laboratory in sterile plastic containers (20L).Immediately after transportation to the laboratory to the laboratory the physico-chemical characteristic analysis was carried out by following the standard methods[3].

LC₅₀ was determined by multiplying it with the constant factor 0.25[4]. Acclimatized and apparently healthy, uninjured and uninfected fish specimens were taken. 10 fishes each were exposed to 50L of normal water (control) and six concentrations (20%, 25%, 30%, 35% , 40 % and 45%) of dyeing industrial effluent. Each experiment was performed in triplicate. Mortality of fishes was recorded for 96h. The values of mortality were converted into Probit and concentrations into log values and graph was plotted to determine LC50 value.

For behavioral responses and morphological changes, fishes were, exposed to normal water (control) and three sub lethal concentrations (6.875 % and 6.25 %) effluent (treated) for 24h, 48h, 72h, 96h, and 120 hours. Fishes were not fed during the experiment and experiments were replicated.

III.RESULT

Table 1.The percent mortality of fish exposed to different concentration of textile effluent at different hours of exposure.

s.no	Concentration of effluent %	Hours of exposure (Hrs)					
		12	24	48	72	96	120
1	20	0	0	0	0	10	20
2	25	10	30	30	40	50	60
3	30	30	40	50	60	60	75
4	35	40	60	60	70	80	90
5	40	50	70	70	80	90	100
6	45	60	80	80	100	100	100

Table.2.LC₅₀ Concentration of textile effluent for different hours of exposure for *Cyprinus carpio* (Values are in Percentage).

Exposure period(Hrs)	12	24	48	72	96	120	Sublethal Concentration	
							72	96
LC ₅₀ of the effluent(%)	40	32.5	30	27.5	25	24.2	6.875	6.25

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Table .3.Rate of opercular movement of Cyprinus carpio exposed to lethal and sub lethal concentration of textile effluent (Opercular beat / minute).

s.no	Opercular beat / minute		
	Control fishes	Lethal (24 hr)	Sub lethal (5 days)
1	35	96	55
2	26	98	48
3	32	101	52
4	30	97	50
5	28	105	46
Total	151	497	251
Mean	30.2	99.4	50.2
P		P < 0.001	P < 0.05

Table.4.Rate of oxygen consumption of Cyprinus carpio to sub lethal (72 and 96 hr) concentrations of textile effluent after 30 days exposure (unit μlo_2 / body weight / hr).

S.no	Control	30 days exposure in sub lethal concetration	
		72	96
1	0.621	0.3681	0.421
2	0.681	0.3710	0.4018
3	0.672	0.3679	0.4103
4	0.665	0.3680	0.4028
5	0.612	0.3599	0.4021
Total	3.251	1.8349	1.6262
Mean	0.6502± 0.012	0.49702±0.016	0.3252±0.015
P		P < 0.05	P < 0.05

LC₅₀ AND TOXICITY CURVE:

All the fish kept in the control and in sub lethal concentrations of the textile (72 and 96 hr) effluent survived throughout the duration of the experiment .However , the percent mortality of fish varied on the basis of concentration and exposure period .The fish mortality (after exposure 12 , 24 , 48 ,72 , 96and 120 hr) was increased with increasing concentration and exposure time which was shown Table 1.The fish that exposed to higher concentration of textile (except LC₁₀₀) effluent showed symptoms of stress and lethargy during exposure period and died in the short period .This was considered as lethal concentration (45 %) of the textile effluent and the fish survived fro 120 hr was considered as sub lethal concentration of the textile effluent (20 %).

The LC₅₀ values (median lethal concentration) of textile effluent ranged from 40 to 24.2 ml / 100 ml / at 12 to 120 hr respectively (Table.2) .The toxicity curve was plotted based on median lethal concentrations at different durations of the textile effluent for the fish *Cyprinus carpio*.

DETERMENATION OF SUB LETHAL CONCENTRATION:

For textile effluent the sub lethal concentrations were calculated fro 72 hr and 96 hr of exposure as 6.875 and 6.25 respectively (Table.2).One fourth of the LC₅₀ was considered as sub-lethal concentrations (SLC) [5].

BEHAVIOURAL CHANGES:

The test fish, exposed to different concentrations exhibited abnormal behavioural responses. During the exposure fish and, erratic swimming with rapid jerky movement's .Hyper – excitability, spiraling, convulsion and tendency of escaping from the aquarium were also noticed. It was observed that with the increasing concentration and exposure

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time these activities were relatively increased initially and subsequently reduced, expressing the sign of distress. Later on fish struggled hard for aerial breathing with their restrictive swimming movements and indicates poor response to external stimulant.

The body pigments changed from normal colour to pale colour at stage in higher concentration especially at 40 ml /100 ml .Mucus secretion in the mouth and around the gills was also noticed and 100 % mortality was observed immediately after exposure in 100 % (Raw effluent) concentration. This was followed by a loss of equilibrium and fish slowly moved upward in the vertical direction .Thereafter , fish become progressively lethargic and lost their sense equilibrium completely .Ultimately the fish lay down on the bottom of aquaria with their belly upward before death.

OPERCULAR MOVEMENT:

As depicted in Table .3. a significant increase in the rate of opercular movements was noticed in lethal and sub lethal exposure concentrations of textile effluent treated *Cyprinus carpio* which was found to be statistically significant compared to control.

RATE OF OXYGEN CONSUMPTION:

The rate of O₂ consumption was lower in textile effluent treated fish *Cyprinus carpio*, when compared to control which was found to be significant at 5 % in 72 hr 1 % level in 96 hr textile effluent treatments as shown in Table 4.

IV.DISCUSSION

Control fishes released in well aerated water were found to be alert and respond actively to slight disturbances. They behaved naturally by showing active movements. Rapid industrialization, urbanization and green revolution are increasing water pollution to an alarming rate. LC50 method for acute toxicity at 96h is safe and reliable method as it detects lethality of pollutants. The 96h LC50 value of dyeing industry effluent was high proving it to be highly toxic among industry effluents. The effects are generally displayed as behaviour responses and morphological changes that lead to genetic changes which become cytologically visible in the tissues. Fish is extremely sensitive in terms of behaviour and any change in behaviour of fishes is related with the toxicity of effluent. Morphological changes pointed towards stress and injuries caused by effluent. Thus, these parameters are used to determine toxicity caused by the effluent.

Treated fishes exposed to three sublethal concentrations (6.875%, and 6.25 %) of dyeing industrial effluent showed restlessness, erratic body movements, gulping of air at surface or jumping out of water, opercular movements, loss of equilibrium and hitting against the wall. A few changes in the outer morphology were also observed which included ballooning, loosening of scales, redness in eyes, profuse mucous secretion, bleeding from gills and pigmented patches on the abdomen. All these symptoms increased with increase in concentration and duration of exposure. Loss of equilibrium, erratic swimming and restlessness are common behavioral responses in several fishes exposed to a variety of toxicants as recorded in *Rasbora daniconius* exposed to zinc[6], in *Clarias batrachus* exposed to cadmium chloride, carbaryl and malathion [7], in *Channa punctatus* exposed to cypermethrin and *k*-Cyhalothrin [8,9], in *Labeo rohita* exposed to cypermethrin [10], in *Cyprinus carpio* exposed to chlorpyrifos [11], in *Labeo rohita* exposed to sodium cyanide [12], in *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* exposed to fenvalerate [13], in *Oreochromis niloticus* and *Clarias batrachus* exposed to copper sulphate [14]and in *Oreochromis niloticus* exposed to cypermethrin [15]. Hitting against the wall was noticed in *Labeo rohita*, *Catla catla* and *Cirrhinus mrigala* exposed to fenvalerate [13]. Restlessness, loss of equilibrium, hitting against the wall and hyperactivity in fish may occur due to the inactivation of acetylcholinesterase (AChE), leading to accumulation of acetylcholine at synaptic junctions [16; 17; 18and [19].Copious mucous secretion, increased opercular movement and dark pigmentation of body parts were observed in *Rasbora daniconius* exposed to zinc[20], in *Clarias gariepinus* treated with lindane and diazinon [21], [9], in *Clarias batrachus* exposed to carbaryl and malathion[22], in *Heteropneustes fossilis* exposed to dimethoate [23]and in *Oreochromis niloticus* exposed to cypermethrin [15]. Profuse mucous secretion is considered to be a defence mechanism to neutralize the effect of toxicant and to avoid it. [24] Suggested that mucous produced coagulates with the

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toxicant and prevents its coetaneous entry into the body. Surfacing or gulping of air might occur due to a demand of higher oxygen level after exposure [25].

The results of the present study clearly reveal that higher concentration (6.825%) and longer exposure period (96h) of dyeing industry effluent is highly toxic to the fish. The effect of other two concentrations cannot be ignored. Prolonged exposure to even lower concentrations induces behavioral and morphological changes in fishes. These changes and responses indicated stress in fishes which can further lead to death and reduction in fish fauna. This type of study helps to understand the effect of industrial effluents on fishes so as to determine safe environmental concentration where there is no stress and lethality to fishes.

V.CONCLUSION

To sum up from the observations made in this investigation, it may be pointed out that the changes obtained on the biological parameter on the fish treated with textile effluents. It is therefore, needless to say, that the textile effluents have factors which induced changes which go against wellbeing of the aquatic organism like fish and therefore, they become potent abiotic pathogens adversely affecting the aquatic biosphere. Hence the study of toxicological bioassay all the more becomes a necessity to assess the water quality.

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