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Physicochemical analysis of textile and paper mill effluents and its impact on mortality and behavior changes in Channa punctatus.

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Abstract

Present study envisaged to evaluate the toxic effect of textile and paper mill effluents (collected from industries located in Kathua, Jammu) on the mortality and behavior of fish, Channa punctatus and to study physicochemical parameters of effluents such as pH, temperature, electrical conductivity (EC), total dissolved solids (TDS), total solids (TS), total suspended solids (TSS), dissolved oxygen (DO), free CO_2 and total alkalinity. Fish were exposed to 0, 10, 20, 40, 60, 80 and 100% concentrations of textile and paper mill effluents for 96h. Fish became restless and tried to jump out of water initially and then settled at the bottom of the pool and hardly swam throughout the study. A thick coat of mucus was present on the dead fish. No mortality was observed at lower concentration of effluents while 20-30% mortality was observed at higher concentration of effluents. The value of EC, TDS, TS, TSS and free CO_2 were found to be higher but the value of DO and total alkalinity were found to be lower as compared to control. The results indicate that the effluents are very toxic to the fish and causes marked behavioral changes and mortality at higher doses.

Keywords**:** *Channa punctatus, Effluents, Kathua, Mortality, Physicochemical.*

1. Introduction

Water pollution caused by industrial effluents has been one of the major issues of global environmental concern. Continuous disposal of effluents into the water bodies has deteriorated the quality of water because of the mixing of various chemicals present in the effluent[1]. It reduces the concentration of oxygen in water due to the presence of hydrosulfide group compounds. Also, it blocks the passage of light through the water body and is detrimental to the water ecosystem[2]. The textile and paper mill industries are one of the oldest industries in our country and there has been tremendous expansion of these industries during last 25 years and contributes a lot towards the pollution in our aquatic environment[3]. These industries are large producers of wastewaters which contaminates the natural water bodies altering their physicochemical properties[4]. The impact of these industries on environment, both in terms of the discharge of pollutants and of the consumption of water and energy has long been recognized[5].

Fish, being a rich source of protein, is a staple food in many regions of the world, and fish perform all its physiological functions such as feeding, swimming, breeding, digestion and excretion in water[6]. Survival and growth of fish depends upon the availability of quality water[7]. Water quality is defined by its physicochemical properties in terms of the chemical, physical and biological contents of the water. Some important physicochemical parameters such as temperature, pH, dissolved oxygen, total suspended solids, total dissolved solids and total alkalinity are the limiting factors for the survival of aquatic organisms. Water quality parameters should be in tolerable limits for living organisms to perform optimally. The body functions are adversely affected by a sharp drop or an increase in these limits[8,9].

Therefore, the present study was aimed at physico-chemical evaluation of textile and paper mill effluents of industry located in Kathua, Jammu and its impact on mortality and behavior responses in *Channa punctatus*.

2. Materials and Methods

2.1 Chemicals

All AR grade chemicals used for the present study were purchased from Sigma-Aldrich, SRL and Himedia.

2.2 Analysis of Physicochemical Parameters

The effluent samples were collected from a small scale Textile Dyeing and paper mill Industry in Kathua, Jammu. Sampling of effluents was carried out in Glass bottles. The pH, temperature and electrical conductivity (EC) of the effluents were determined at the spot by using soil and water analysis kit (Decible-DB-1203) manufactured by Decible, India Ltd. and rest of the physicochemical parameters were determined instantly after bringing the samples in the laboratory. Total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), free CO_2 and total alkalinity were measured as per the method given by[10].

2.3 Animal and Treatment

Channa punctatus were collected from local market, Amritsar, Punjab. The fishes were brought to the laboratory for acclimatization and kept in 200L aquarium for 15 days before the experiment. Fish were fed on a commercial Toya pacific green floating pellet feed *ad libitum* during acclimation as well as experimental period except for 24h preceeding exposure and sacrifice. Tap water was used as diluent and control after dechlorination. Test water was changed every 24h during the short term study. All fishes were exposed to 0 (control), 10%, 20%, 40%, 60%, 80% and 100% of textile and paper mill effluents for 96h. Mortality and behavioral changes were examined throughout the study.

2.4 Statistical Analysis

Data were subjected to ANOVA for finding out the differences in physicochemical parameters before and after exposure and within the groups. The results are reported as Mean±S.E. The differences were regarded as statistically significant when $P<0.001$ to $P<0.05$.

3. Results and discussion

3.1 Behavioral study

Fish exposed to lethal concentration of textile and paper mill effluents for 96h were studied in terms of general behavior and mortality.

The fish act as a bioindicator species and it responds to water pollution with great sensitivity[11]. Fish is extremely sensitive in terms of behavior also and any change in behavior of fishes is related with the toxicity of the chemical[12]. On exposure to the higher concentration of effluents the fish became restless, tried to jump out of the water, gradually they stopped swimming, gulping intensity increased and remained static in a corner of the aquarium. Fish swim with jerky movements and fish turned upside down before mortality. The exposed fish had increased mucus secretion and dead fish were covered by a thick coat of mucus. Color of the body, gills and viscera changed on exposure to higher concentration of effluents. Exposure to the effluents also brought a decline in feeding intensity. In the present study, no mortality was observed at 10, 20, 40% concentration of effluents but 20% and 30% mortality were observed at 60-80% and 100% concentration of effluents, respectively after 96h. Similar results were observed when *Labeo rohita* and *C. punctatus* were exposed to paper mill effluent[13]. Significant changes in opercular movement, locomotion, behavior as well as body colour were observed in *Clarias batrachus* on exposure to Nuvan[14]. The industrial effluent affects normal vision, locomotion and behavior of the organism[15].

Concentration (%)	**No. of fishes exposed**	**Mortality in Textile mill effluent**	**Mortality in Paper mill effluent**
Control (0)	10	--	--
10	10	--	--
20	10	--	--
40	10	--	--
60	10	02	02
80	10	02	02
100	10	03	03

Table 1. Number of mortality of *Channa punctatus* at different concentrations of textile and paper mill effluents after 96h.

3.2 Physicochemical analysis

The textile and paper mill effluent samples were brown in colour, with slight pungent smell and pH (7.92-7.94). pH indicates the acidity and alkalinity of water samples. pH is affected by biological activities[16]. In the present study, pH of both the effluents ($p<0.001$) were found to be slightly higher than control. The higher pH indicates the alkaline nature of effluents. Alkaline pH of textile effluents is caused by the process of bleaching[17]. The pH of the effluent alters the physico-chemical properties of water which in turn adversely affects aquatic life, plant and humans[18].

S. No.	Physicochemical Parameters	Control	Textile effluent	Paper mill effluent
1	pH	7.19±0.03	7.92±0.01	7.94±0.02
2	Temperature (^{0}C)	20.8±0	20.8±0	20.81±0.03
3	Electrical Conductivity (µm hos/cm)	580±0	616.67±3.33	613.33±3.33
4	Dissolved Oxygen (mg/l)	5.63±0.07	3.43±0.03	3.50±0.15
5	Free CO_2 (mg/l)	17±0.58	27.67±0.33	23.67±0.33
6	Total Alkalinity (mg/l)	278±1.15	236.67±1.45	232.67±0.88
7	Total Solids (mg/l)	0.33±0.03	0.87±0.03	0.71±0.03
8	Total Dissolved Solids (mg/l)	0.17±0.03	0.40±0	0.33±0.03
9	Total Suspended Solids (mg/l)	0.17±0.03	0.47±0.03	0.55±0.07

Table 2. Physicochemical parameters of Control, Textile and Paper mill effluents.

The purity of water is determined by measuring Electrical Conductivity[19]. EC measures the electric current, which is proportional to the mineral matter present in water. Conductivity is thus the measurement of total dissolved solids (TDS) in water. It is very important parameter for determining the water for drinking and agricultural purposes. In the present study, EC values of textile and paper mill effluents were recorded to be higher (616.67 and 613.33µm hos/cm, respectively; $p<0.001$) as compared to control. High EC values indicate the presence of high amount of dissolved inorganic substances in ionized form[20,21].

TDS content in water is a measure of salinity. TDS are various kinds of mineral substances present in water. Some dissolved organic matter may also contribute to total dissolved solids[22]. A high content of dissolved solid elements affect the density of water, influences osmoregulation of freshwater organisms, reduces solubility of gases and utility of water for drinking, irrigational and industrial purposes[23]. In the present study, high TDS values of textile

and paper mill effluents ($p<0.001$) were observed as compared to control. Increasing trend of dissolved solid with increasing pollution of water was also observed by[22].

Oxygen level of water is depleted due to presence of suspended solids[24]. In the present study, high TSS values of both effluents ($p<0.001$) were observed as compared to control. High level of TSS could be attributed to the intense color of various dyestuffs used in textile mills[25]. Textile effluents are high in suspended solids and implications of increased suspended particles could range from reduced primary production to poor visibility of sight dependent organisms, hence increasing their vulnerability to production[26]. The high TSS observed can be further attributed to the dye contents which in turn contain heavy metals that bind to river particles thereby having the potential to cause increased concentration of suspended solids[27].

Total Solids (TS) is a measure of all the suspended, colloidal and dissolved solids in a sample of water. In short, TS are sum total of the values of TDS and TSS. Total Solids are directly proportional to temperature and rarely varies inversely to the water level[16]. Waste water contains variety of solid materials. Total solids are determined as a residue left after evaporation of unfiltered samples[18]. In the present study, TS values of both effluents ($p<0.001$) were found to be higher as compared to control. High level of TS reduces the clarity of the water. This decreases the amount of sunlight able to penetrate the water.

Dissolved oxygen is the most well-established indicator of water quality. Dissolved oxygen is absolutely essential for the survival of all aquatic organisms and the effects of effluent on marine life are largely determined by oxygen balance of the water[16]. In the present study, DO values ($p<0.001$) were found to be lower as compared to control. The low level of DO in the sample may be attributed to the high level of organic loads and corresponds with the high total solids content of the sample[25].

Carbon dioxide is colorless, odorless gas and soluble in water. Less than 10 ppm of free CO_2 is normally present in surface water. When CO_2 concentration increases, oxygen concentration in water decreases. Increased level of CO_2 in water makes it more difficult for aquatic organisms to use limited amount of oxygen present. In the present study, Free CO_2 values ($p<0.001$) were found to be higher as compared to control. Increased level of free CO_2 could be due to the discharge of carbonate ions[28].

Alkalinity of the water is its capacity to neutralize a strong acid and is characterized by the presence of all hydroxyl ions capable of combining with the hydrogen ion. In the present study, total alkalinity values ($p<0.001$) were found to be lower as compared to control. Alkalinity in natural water is due to free hydroxyl ions[22].

4. Conclusion

It is concluded that textile and paper mill effluents are not safe to *C. punctatus*. This type of study can be useful to compare the sensitivity of various species of aquatic animals. A major reduction in the concentration of various compounds and metals in industrial effluent is necessary. It should be more properly treated using various physical, chemical and biological methods. The present data suggests a need to implement common objectives and programs for improvement in the textile industrial waste water treatment methods.

5. Conflict of interest

There is no conflict of interests.

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