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Effect of Textile Industrial Effluents on Stress Related Changes in Biochemical Response of Fresh Water Fish *Oreochromis mossambicus*

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Abstract

The paper deals with acute toxicity (96 h) experiment on the fresh water fish *Oreochromis mossambicus* exposed to textile (cotton) industrial effluent (TIE). TIE was collected from the source of Manipal textile industrial waste water treatment outlet ; analyses of the physico-chemical parameters i.e. pH, COD, BOD, TSS, color and total chromium levels were estimated. The observed values of physico-chemical parameters showed the norms of safe limit laid down by WHO. The LC_0 and LC_{50} concentrations were 18 and 26% for TIE. After acute toxicity experiments for LC_0 and LC_{50} concentrations of TIE, various tissues viz. gill, liver, muscle and kidney were obtained separately from control, LC_0, and LC_{50} groups. These tissues were used for biochemical estimations. The glycogen content in all the tissues decreased considerably upon acute toxicity except muscle and kidney in LC_0 group. Total protein content decreased in all the tissues except liver and kidney in LC_0 group, in LC_{50} group significant decrease in total protein content in all the tissues observed after acute exposure, when compared to control group. In general, total lipid content decreased in all tissues after exposure with LC_0 and LC_{50} concentrations of TIE. The results showed that textile mill effluent caused marked depletion in biochemical changes in various tissues of the fish Oreochromis mossambicus after acute exposure.

Key words : *Oreochromis mossambicus,* Acute toxicity, Textile industrial effluents, Biochemical composition.

The textile industry is one of the greatest generators of liquid effluent, due to high quantities of water used in the dyeing processes. The effluents from these industries are complex containing wide variety of dyes and other products. The textile industrial effluents (TIE) generally contain high quantities of dissolved and suspended solids, organic and inorganic chemicals, high BOD and COD, oils and grease, besides toxic metals which cause deleterious effects on the fresh water fish when discharged to water bodies (1).Hansen et al. (2) and Baghel et al. (3) have reported number of changes in the physiological and biochemical parameter due to stress related changes in fish. Shaffi (4) have studied the various concentrations of industrial effluents on various tissue glycogen and serum glucose, lactate level of nine fish species. Srivastava (5) studied comparative effect of heavy metal contamination in the environment on tissue glycogen of cat fish *Heteropneustes fossilis.* Jana et al. (6) reported increased protein content in liver, kidney, stomach, intestine, testis and ovary when fish Clarius batracus was exposed to heavy metal pollutants. Efects of tannery effluents on muscles and liver glycogen in fish *Sarotherodon mossambicus* was reported by Natarajan (7). Rina et al. (8) reported that alterations and impairment of body electrolyte balance in Channa punctatus. Rajan (9) reported that, biochemical variables i.e. protein, carbohydrate and lipid contents decreased significantly in muscle, liver and intestine of carpio when exposed to subleathal concentrations of textile mill cffluent. Ambrose et al. (10) also observed decline in carbohydrate protein and lipid contents of gill, liver, intestine and kidney of Cyprinus carpio var communis under the toxic stress of sub-leathal concentration of composite tannery effluent. Decrease in glycogen, total protein and lipid in both liver and muscle tissue of fish Channa punctatus (Bloch.)reported with an increase in distillery effluent concentration (11). Considering these the present study was aimed to assess the effect of TIE on the stress related changes on the biochemical composition of gill, liver, muscle and kidney of the fish Oreochromis mossambicus (Peters).

Methods

Survey was made for the selection of industrial

effluents for the present investigation in and around Mainpal, Karnataka. Finally one station from Manipal textile industry were selected, treated effluents discharged into the waste water canal ; Samples were taken from the textile industries treatment plant waste water processing outlet.

The effluents from the textile mill plant at Manipal were collected from 0010-1200 hours on 1,10,20 and 30 days during April 2010, and brought to the laboratory in 20 liter container for physico-chemical and toxicological studies ; certain physico-chemical parameters were analyzed on the spot, remaining parameters i. g., BOD was measured by standard methods (12), COD, TSS, heavy metals and color analysis were done by following standard methods (12) and toxicological studies were performed in the laboratory. The effluents were analyzed for different heavy metals using Atomic absorption spectroscopy (Perkin Elmer, USA).

Animals

Healthy teleost fish of *Oreochromis mossambicus* (Length 10-14 cm, weight 26-32g) were collected from the state fisheries department nursery. The fish were thoroughly washed with 0.1% $KMnO_4$ and acclimatized for 15 days. The fish was fed daily with fish feed from Hindustan lever Ltd ; up to 24 hours prior to initiation of the experiment. The water of the test medium was changed at regular intervals. The physico-chemical parameters of the medium was evaluated using APHA standard methods.

Biochemical Studies

After acute toxicity (96 h) experiments, a live fish was immediately sacrificed (seven from each group) from control, LC_0 (TIE, 18%) and LC_{50} (TIE-26%) group separately to obtain gill, liver, muscle and kidney. The pooled samples of these organs were stored at -40C in the deep freezers, weighed and used for biochemical estimations. The total glycogen content were measured following Dezwan and Zandee (13), the total protein content was estimated following the technique of Lowry et al. (14) and total lipid content were measured following the method of Folch (15). The values obtained are expressed as mean ± SD. The means were compared with control, levels of significance was statistically calculated by using SPSS ver 7.0.

Results and Discussion

Bichemical Characterization of Textile Industry Effluents

The chemical, biochemical tests performed on effluent samples of textile industry are summarized in Table 1. The water quality analysis results showed that the sampling effluent from Manipal textile industries were violating discharging limits on days 1, 10, 20 and 30. TIE water samples were collected from the industrial treatment outlet 1,500 meters away from the industries. The samples showed determined pH was ranged from 8 to 10.35 ; estimated COD, BOD, TSS, color, total chromium, values above admissible levels prescribed by the Karnataka State Pollution Control Board (KSPCB). The textile industry discharges waste water in the canal. Table 1 shows physico-chemical properties of TIE of samples taken on day 30 for toxicological studies on *O. mossambicus.*

Total Glycogen

Glycogen level in different tissues of the fish and changes in the total glycogen content in gill, liver muscle and kidney of O. mossambicus exposed to TIE after acute exposure for 96 h are shown in Table 2. The glycogen content in all the organs decreased considerably upon exposure to 18% of TIE (LC_0). Although the relative decrease varied form tissue to tissue, the percent depletion was more significant ($P < 0.001$), in liver (-30.69) followed by gills (-26.6) and less significant ($P < 0.05$) in muscles (-2.02) and in kidney (-0.321). In LC_{50} concentration of 26% TIE exposed group these was more significant ($P < 0.001$) percent depletion in the levels of glycogen in liver (-66.82) and gills (-62.50) less significant ($P < 0.05$) decrease in glycogen content was recorded in kidney (-23.39) and muscles (-17.94). The significant percent depletion of glycogen content in various organs due to lethal concentration of (LC_{50}) the effluents.

Total Protein

Changes in total protein in gill, liver, muscle and

Table 1. Chemical and biochemical characterization of textile industrial effluent. (Mean ± SD) ; n = 6.

Parameters	KSPCB stds	Days 1	10	20	30	Range
pH	-	8 ± 1.2	9 ± 0.86	7.9 ±3.216	10.65 ± 1.38	7.9-10.65
COD (mg/l)	250	638 ± 160	459 ± 64	529 ± 78	1380 ± 276	459-1380
BOD (mg/l)	90	169 ± 39	186 ± 59	180 ± 51	318 ± 56	169-318
BOD/COD ratio	-	0.265	0.405	0.340	0.230	0.230-0.405
COD/BOD ratio	-	3.775	2.4677	2.939	4.339	2.467-4.339
TSS (mg/l)	160	1568 ± 126	1398 ± 36	1468 ± 30	1613 ± 98	1398-1613
Color (590 nm)	-	17.6 ± 3	14.8 ± 1	10.169 ± 3.0	16.8 ± 2	10.169-17.6
Total Cr (mg/l)	2.0	4.96 ± 3	3.69 ± 1.86	4.03 ± 2	5.8 ± 1.26	3.69-5.8
Chlorides (mg/l)	-	14.6 ± 2.0	26.3 ± 6.2	10.6 ± 3.168	24.6 ± 2	10.6-26.3

kidney of *O. mossambicus* exposed to textile industrial effluent, after acute exposure for 96 h are shown in Table 2. Total protein content decreased significantly ($P < 0.05$) in kidney (-26.55) followed by gill (-22.24) and muscles (-15.30) there was non significant increase in protein in liver (9.49) upon acute exposure to 18% of textile effluent (LC_0).

In LC_{50} concentration of TIE exposed group there was less significant decrease in protein content ($P < 0.05$) was recorded in kidney (-13.23) and in muscles (-17.94). There was significant increase in gill (-26.81), while non significant decrease in protein was observed in liver (9.49) as compared to control upon acute exposure to 26% of TIE.

Total Lipid

Changes in the total lipid content in various tissues of *O. mossambicus* exposed to TIE after acute exposure for 96 h are shown in Table 2. The lipid content in all the tissue decreased considerably upon the acute exposure to LC_0 concentration of TIE. Although the relative decrease varied from tissue to tissue, the percent depletion was significant ($P < 0.05$) in muscles, increased percent depletion of lipid content with LC_0 concentration of TIE was observed ($P < 0.001$) in kidney (-25.86), liver (-25.29) and in gill (-23.4) due to the subleathal concentration.

In LC_{50} group there was a significant ($P < 0.001$) depletion in lipid content in liver (-53.42) followed by kidney (-46.980), gill (-38.46) and while less significant ($P < 0.05$) in muscles (-13.64) due to the leathal concentration (26%) of TIE as compared to control.

In the present study, *O. mossambicus* exposed to subleathal concentration of TIE, there was depletion in glycogen level. The finding can be correlated with similar effect due to different effluent reported by Muley et al. (16), Balaji and Chokalingam (17) ; Maruthi and Rao (11). This decrease in tissue glycogen may be due to glycolysis for production of energy to overcome toxic effects of the effluents. Decrease in the glycogen content has also been reported by Shaffi (4) and Muley et al. (16). Similar depletion in glycogen content in this study may be attributed to its utilization to meet high energy demand created by stress of effluents. This could have happened by rapid glycogenolysis and inhibition of glycogenesis through activation of glycogen phosphorylase and depression of transferases (18—20).

In the present study, there was decrease in protein content of all organs in subleathal concentration LC_0 with 18% of TIE, there was decrease in protein content in gills, muscles except kidney and liver. While decrease in LC_{50} concentration of TIE there was significant decrease in protein content in all the organs studied in leathal concentrations.

Significant decrease in total protein content indicates that stress due to effluent exposure induces proteolysis. Stress has been reported to accelerate protein metabolism in man and animals (21).

Similar findings were reported by Muley et al. (16) with different industrial effluents in the *Labeo rohita* ; where the total protein content decreased. Protein decrease may be due to stress in fish as protein is likely to undergo hydrolysis and oxidation through TCA cycle to meet the increase in liver protein, may be due to increase in synthesis of detoxification enzymes as suggested by Chitra (22). The alteration in the tissue protein, in the present investigation suggests disturbances in the

Table 2. Effects of textile industrial effluents on glycogen, protein and lipid content in various organs of the fish *Oreochromis mossambicus* after acute exposure (mg/100 mg wet weight). The values in parentheses are percent change. *$P < 0.05$; ** = $P < 0.001$; NS = Non significant ; mean ± SD of seven animals.

Organs	Gill			Liver		
	Control	LC_0	LC_{50}	Control	LC_0	LC_{50}
Glycogen	0.541±0.0082	0.397±*0.027 (-26.6)	0.203±**0.012 (-62.50)	6.203±0.017	4.299±**0.01 (-30.69)	2.058±**0.013 (-66.82)
Protein	26.007±0.065	20.278**±0.008 (-22.24)	19.087**±0.026 (-26.81)	16.344±0.371	17.895^{NS}±0.128 (9.47)	14.365*±0.254 (-12.11)
Lipid	0.693±0.015	0.517**±0.019 (-23.4)	0.423**±0.007 (-38.96)	0.775±0.021	0.579**±0.008 (-25.29)	0.361**±0.0121 (-53.42)

Table 2. Continued.

Organs	Muscle			Kidney		
	Control	LC_0	LC_{50}	Control	LC_0	LC_{50}
Glycogen	0.396±0.012	0.323±^{NS}0.018 (2.02)	0.323±*0.018 (-18.43)	0.218±0.0086	0.2187±*0.008 (-0.321)	0.167±**0.006 (-23.39)
Proten	29.233±0.029	24.759*±0.16 (-15.30)	23.986*±0.169 (-17.94)	19.676±0.06	24.912**±0.097 (26.55)	17.073*±0.11 (-13.23)
Lipid	0.572±0.0094 (-7.16)	0.531±*0.0084 (-7.16)	0.494*±0.09 (-13.64)	0.662±0.015	0.491**±0.007 (-25.83)	0.351**±0.007 (-46.98)

physiological activity.

In the present study, there was depletion in the hepatic total lipid could be due to their active mobilization towards the blood and or tissue metabolism (16). The decrease might be due to the utilization of lipid to meet the additional energy requirement under environmental stress with TIE. Toxic substances might have accumulated in the brain of fish, causing disintegration of nerve cells, clotting of blood and reduction in transport of oxygen to brain (23).

Decrease in lipid content noticed in different organs in this study may be due to inhibited lipid synthesis and mobilizing the stored lipid, either through β-oxidation or through gradual unsaturation of lipid molecules (24). In the present study showed that, LC_0 and LC_{50} concentrations of TIE altered the biochemical composition (glycogen, protein and lipid) of various organs of the experimental animal, due to utilization of biochemical energy to counteract the toxic stress caused due to pollutants present in the textile industrial effluents.

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