The Environment

THE ENVIRONMENT

Volume 1, Issue 1 (2017) 52-57

Research Article

The Study of Polluted Water of Shahdara Drain using Fish Biomarkers

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ABSTRACT

The biomarkers are increasingly being used to assess the effects of various micro pollutants on living organisms and the biotic community. This paper examines the lethal effects of the pollutants of Shahdara drain on the fish in terms of select four biomarkers -Super Oxide Dismutase (SOD), Catalase (CAT), Lipid peroxidation activity (LPA) and Total Protein (TP). The outcome of the study reconfirms the suitability of biomarkers in assessing the impact of various pollutants present in the water body on the biotic community and the status of water quality of the Sahadara drain, one of the major water channels in Delhi.

Keywords: Super Oxide Dismutase (SOD), Catalase (CAT), Lipid peroxidation activity (LPA), total protein (TP), drain water pollution.

Introduction:

In the last few decades, the contamination of fresh water by a wide range of pollutants has become a major concern for the aquatic environment (Ugokwe and Awobode, 2015; Adedeji et al., 2012). Various organic and inorganic wastes in industrial and domestic effluents are discharged intentionally or unintentionally into the water bodies which is major cause of water pollution. Most of these effluents contain toxic substances which enter and get accumulated in aquatic fauna and flora causing several physiological changes in them (Berman and Lal, 1994).

The polluted water may cause harm to the beneficial species either directly affecting their life or indirectly through breaking the biological food chains (Bhanu and Deepak, 2015).

The Shahdara canal, created in 1976 to carry flood water away from the Yamuna bed is today known as a drain and contributes mainly pollutants of industrial origin (CPCB, 1999 – 2005; Dhillon et al., 2013). The drain contributes as much as 20 per cent by volume and 25 per cent by pollution load to Yamuna in Delhi.

Fishes are being used as models for the evaluation of pollution in aquatic environment (Pandey et al., 2011a, 2011b). The significance of the zebrafish model has been well established for ecotoxicological studies due to its wide distribution and availability throughout the year, and easy maintenance in the aquaria/wet lab (Watts et al., 2012). Moreover, chemical analyses of the sample are expensive and it is not feasible to measure all classes of chemicals likely to be found in an aquatic environment given the complex mixture. On the other hand, biomarkers, representing toxicant-induced changes in biological systems, can serve as links between an environmental contamination (cause) and its effects, providing therefore unique information on the ecosystem health (Maria et al., 2009; Carvalho et al., 2012).

Biomarker was widely used in the research of ecological toxicology and ecological pollution risk evaluation of the water bodies. So, the use of biomarker as the early warning indicator for toxic effect is becoming a priority research areas (Datta et al, 2013; Zhang et al. 2014). Hence, aquatic environment is a sink for many environmental contaminants that can be absorbed by aquatic organisms leading to disturbance of antioxidant /pro-oxidant balance in fish (Lackner, 1998; Livingstone, 2001, Lushchak, 2011). The fish tissues consistently produce reactive oxygen species (ROS) during environmental stress leading to oxidative stress. The oxidative stress is due to overproduction of ROS in the tissues of animals and is one of the important mechanisms in toxic conditions (Livingstone, 2001; Livingstone, 2001; Bhanu and Deepak, 2015). Moreover, depending on the source of pollutants, steady-state ROS concentration can be enhanced transiently or chronically, disturbing cellular metabolism and its regulation and damaging cellular constituents (Lushchak, 2011). Synergistic or antagonistic effects of mixtures of pollutants can hardly interpreted and predicted from the chemical analyses alone; some contaminants are substantially accumulated in specific tissues without recording toxic effects (Viarengo & Nott, 1993). The superoxide dismutase (SOD), catalase (CAT), Lipid peroxidation activity (LPA) and Total protein (TP) are the most common biomarkers used as the environmental toxicity indicator.

The objective of the present study was to evaluate the biochemical changes in fish like Total protein (TP), the lipid peroxidation activity, the activity of antioxidant enzymes, superoxide dismutase (SOD), catalase (CAT), were estimated to know the enzymatic defense systems in the zebrafish due to deleterious effect of pollution.

Material and Methods

To assess the impacts of various contaminants on zebrafish (*Brachedenio rerio*), the waste water sample from Shahdara drain was used. The fishes (25-35 mm long) were exposed in the drain water sample for a period of 1 hour. Dilution water as used for toxicity test was also used as a reference (Control) for biomarker study. Since the size of zebrafish was quite small, as such the entire body was used to extract enzymatic and non-enzymatic determinants (Biomarkers). Out of the four selected biomarkers three enzymatic biomarkers were assessed indirectly, i.e. on the basis of the rate of conversion/concentration of initial chemical or end product of a reaction, the rate of which is influenced by the biomarker.

Whereas, protein components was assessed directly, the activities of SOD, Catalase and Lipid peroxidation was assessed in terms of inhibition in nitrite formation, reduction in Hydrogen peroxide and increase in Malondialdehide concentration. Analyzing the biomarkers, acute toxicity test (for Toxicity Factor) was also conducted on the sample water from Shahdara drain using four physico-chemical parameters, i.e. pH, Chemical Oxygen Demand (COD), Biochemical Oxygen demand (BOD) and Suspended solids (SS).

Results and discussion:

The results of trial study of biomarkers using Shahdara drain water sample are depicted in Table1 and Fig. 1 & 2. The results of physico-chemical analysis (Table 2) reflects that the drain water was highly polluted except in terms of pH. Toxicity test value of $T_{F=}$ 4 (i.e. minimum 4 times dilution of sample is required for 100% survival of test organisms for a period of 48 hours) also indicates that the drain water was toxic for fishes.

Table 1: Biomarkers activities in Zebrafish

Type of fish	SOD (nMoles nitrite formations inhibited/gmfw/min)	CAT (µMoles of H_2O_2) /gmfw/ min)	LPO (MDA µgm /g fw)	T P (µgm/gmfw)
Control	165.39	26.66	1.51	1527
Exposed fish	189.64	19.26	2.50	1384

Table 2: Wastewater quality of Shahdara drain (September, 2016)

pH	COD, mg/l	BOD, mg/l	SS, mg/l	Toxicity (T_F)
7.55	25	72	138	4

The effects of toxicants reflected by biomarkers in exposed fish in comparison to the control fish are clear from Table 1, Fig. 1 and Fig. 2. Increased SOD activity in exposed fish (high inhibition rate of nitrite formation) indicates the effects of drain water, in comparison to the control as nitrite formation is inversely proportionate to SOD activity. Catalase increases the decomposition of Hydrogen peroxide (H_2O_2) into water and Oxygen i.e. catalase activity is directly proportionate to consumption rate of H_2O_2. The study reflects a low conversion rate of H_2O_2 in exposed fish because the catalase activity is suppressed by toxicants of drain water. Lipid peroxidation (LPO) is directly proportionate to the formation of Malondieldehyde (MDA). Increased LPO activity induced by toxicants resulting in high concentration of MDA in exposed fish as compared to control one. Protein contents decline in the presence of stress condition of fish caused by toxicants/pollutants is also supported by the study (Table1 and Fig.2).

The range of percentage decrease/increase in biomarker activities in the exposed fishes in comparison to the control fish is presented in Fig.3. It was found to be in the range of 9 % (total protein reduction) to 66% (lipid peroxidation activity). As expected, the study reflects that non enzymatic biomarkers indication is weak as compared to enzymatic biomarkers.

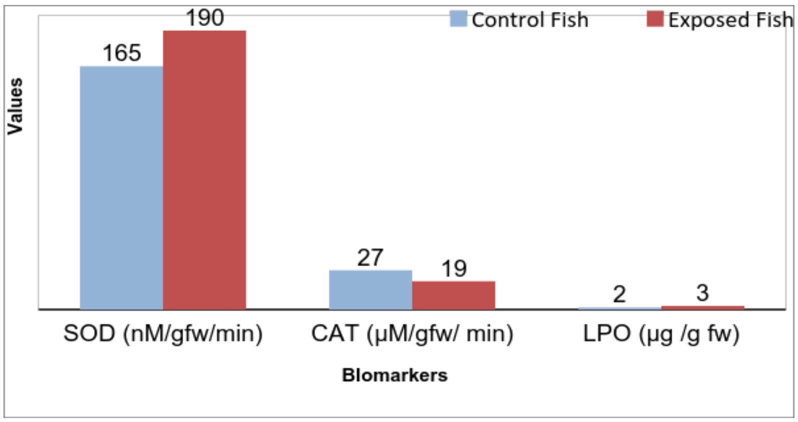

Fig. 1: Effect of the drain water on enzymatic biomarkers

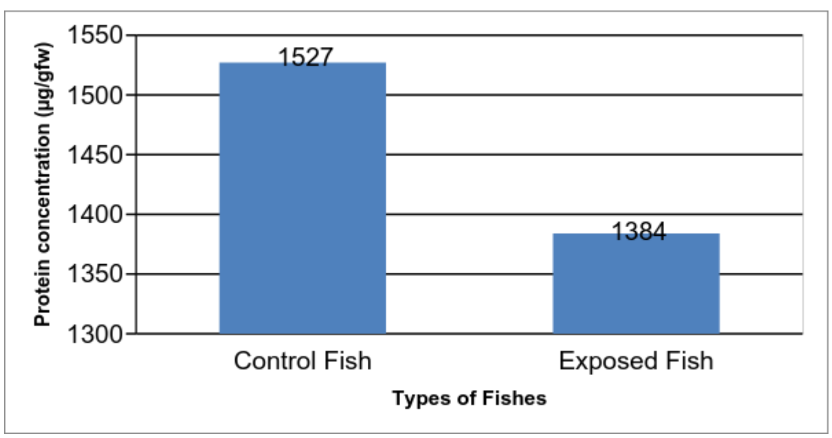

Fig. 2: Effect of the drain water on non-enzymatic biomarkers

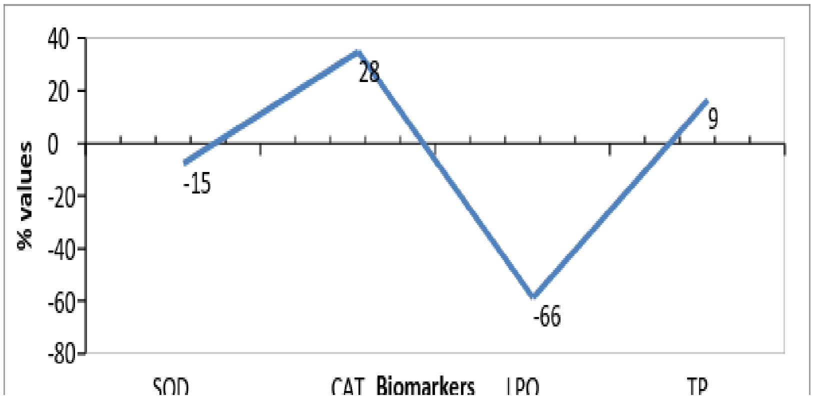

Fig. 3: Percent reduction/increase in activities of biomarkers

Conclusion:

The study of the four selected biomarkers supports the findings of physico-chemical analysis and toxicity test. The outcome of the study also supports the decisive application of biomarkers in the assessment of environmental conditions of aquatic bodies using fishes. This type of study may also be helpful in finding suitability of fishes of a particular water body for human consumption.

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