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Respiratory distress of *Cyprinus carpio* exposed to sub lethal concentrations of textile bleaching effluent

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ABSTRACT

Over stimulation or depression of respiratory activity is one of the most important manifestations of toxicity of the chemical pollutants. In this study, effect of textile bleaching effluent on the oxygen consumption rate of *C. carpio* was evaluated. LC_{50} 24 hr of the effluent was calculated according to Finney's method of probit analysis and was found to be 27.23%. Fish were divided into four groups in three replicates and exposed to 0, 1.5, 2 and 2.5% of effluent concentration for 28 days. Results showed that rate of oxygen consumption increased in the first week of exposure to effluent compared to control. From the second week of experiment, the oxygen consumption of fish started declining. A statistically significant reduction (P^ 0.01) in the O_2 consumption was recorded in all the test individuals. Results were discussed in the light of toxicity of effluent.

***Key words**: Oxygen consumption, C. carpio, Textile effluent, Sub-lethal concentrations*

Introduction

Clean drinking water is an essential human requisite for the sustenance of life. Clean water is also a sine qua non for the development of fishery resources. Disposal of industrial and domestic wastes into lakes and rivers pollute the fresh water and make it unpotable. Textile industries are the major sources of pollution due to the nature of their operations which require high volume of water that eventually results in higher waste water generation (Nemerow, 1978). Uptake of textile effluents through food chain in aquatic organisms may cause various physiological disorders like hypertension, sporadic fever, renal damage, cramps etc. (Karthikeyan *et al*., 2006).

The fact that increasing use of contaminating chemicals in many industrialised parts of the world makes the development of ecotoxicity measurements an absolute necessity (Brando *et al*., 1992). Fish are ideal sentinels for bioassays of various stresses and toxic chemical exposure (Halappa and David, 2009). Being oxygen regulators, carps are able to maintain their oxygen consumption at a constant level along a gradient of environmental oxygen concentrations, until a critical oxygen concentration is reached, below which oxygen consumption begins to fall. Under conditions of stress, this critical oxygen is likely to increase, reflecting the decreased capacity of fish to cope with environmental perturbations (Dube and Hosetti, 2010).

Toxicity of a substance is known by its capacity to cause adverse effects on the living organisms. Toxic impact may bring about physiological, biochemical or pathological alterations in the organisms; the signs of toxicity may reveal symptoms of illness varying from simple local effects - structural and behavioural (Shivakumar *et al*., 2005) to com-

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plex disorders. The intoxication events in fish start with exposure to toxic substances (Ilavazhahan *et al*., 2017), subsequently absorbed into viscera causing an internal exposure (Tilak *et al*., 2005) converted into metabolites which may be either more toxic or less toxic. Subramanian (2004) stated that the sequences of events and interactions of toxic substances with target molecules of organisms depend on various factors like nature of toxicant, duration of exposure, physiological state of organisms, biotic and abiotic factors of environment.

Toxicant in the environment mainly enters into the fish by means of respiratory system. Respiratory activity of fish is often the first physiological response to be affected by the presence of toxic pollutants in the aquatic media (Neelima *et al*., 2016). Hence an attempt has been made to evaluate the toxicity of sub lethal concentrations of 'treated' textile bleaching effluent on the fresh water fish, *C. carpio*.

Materials and Methods

Fingerlings of *C. carpio* (wt. 1 ± 0.5g) were collected from the Fishery Farm, Aliyar Dam. They were acclimatized to laboratory condition (28 ± 2°C) in glass aquaria. The fish were fed *ad libitum* with rice bran-oil cake mixture and commercial pellet feed at 9, 12 and 15 hrs daily. Feeding was stopped 24hr prior to experiment. Toxicity of treated textile bleaching effluent was studied by employing static bioassay method as described by Trivedy *et al*. (1987). LC_{50} values of effluent to *C . carpio* for 24 hr was obtained by probit analysis of Finney (1971). Considering the range of 'application factors' (Anderson and D' Apollonia, 1978) by chronic and sub lethal tests, three sub lethal concentrations of treated effluent (1.5 %, 2% and 2.5%) were evolved in order to perform the studies. Three groups of fish as 5 each were introduced to medium of sub lethal concentration. Control group was maintained in normal tap water. Oxygen consumption rate of fish was evaluated once a week for four weeks following Winkler's iodometry method as described by Welsh and Smith (1961) and expressed in ml/g/hr/l. Data was subjected to standard statistical methods and represented in suitable graph.

Results

Rate of oxygen consumption of control and effluent treated fish are recorded (Figure 1). In the first week of observation, the experimental group recorded higher oxygen consumption rate of 0.4590ml/g/hr, 0.5148ml/g/hr and 0.5331ml/g/hr in 1.5%, 2% and 2.5% effluent concentration respectively compared to control. From the second week of experiment, the oxygen consumption of fish started to decline. In the second week, oxygen consumption rate was 0.4045ml/g/hr, 0.3862ml/g/hr, 0.3494ml/g/hr respectively in fish exposed to 1.5%, 2% and 2.5% effluent. Still, more reduction was observed in third and forth weeks as well. A statistically significant reduction (P^0.01) in the oxygen consumption was recorded in all test individuals.

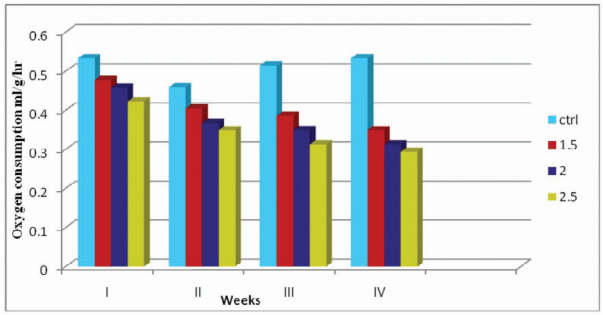

Fig. 1. Changes in the rate of oxygen consumption (mL/g/hr) of *Cyprinus carpio* on exposure to sub lethal concentrations of treated textile bleaching effluent for 28 days

Discussion

It has been reported that textile plants produce highly toxic discharges (Dorn *et al*., 1993). Ademoroti *et al*. (1992) found that residual water from toxic textile facilities carried highly concentrated pollutants and that toxicity was worsened by the presence of ClO^-. Toxic heavy metal also promotes depletion of dissolved oxygen and destabilizes ability of water to reduce microbial loads and thus its ability for auto purification.

Time dependant variations occurred in the rate of oxygen consumption in effluent treated fish. Rate of oxygen consumption increased in the first week of exposure to effluent compared to that of control. Thereafter, the levels decreased with a sharp decline on day 28 th of study period. Similar observation was made by Dube and Hosetti (2010), where the fish exposed to one third and one fifth sub lethal concentration of sodium cyanide depicted increased

oxygen consumption on day 1 to day 5 and decreased on day 10 to 15 compared to control. Neelima *et al. (*2016) reported that, in sub lethal concentrations of cypermethrine 25% EC, *Cyprinus carpio* showed an increased tendency in oxygen consumption during initial time of exposure and a gradual decrease during the subsequent study period.

Fish in the sub lethal concentration were under stress, but was not fatal (Murthy *et al*., 2013). The enhancement of oxygen uptake during the initial phase may be due to excitement and excessive muscular activity caused by pollutants stress (Webb and Brett, 1972) and the animal also try to adjust with the new steady state of metabolism (Jawale, 1985) or to boost up the oxidative metabolism for an increased supply of energy (David *et al*., 2003) or to the initiation of specific protein synthesis or increased to detoxify the toxicant (Connell *et al*., 1999) which is expected to be accompanied by an increase in respiration rate.

The declining respiratory rates recorded in the subsequent period suggests that sodium hydroxide and other strong alkalis could produce asphyxiation by coagulation of gill secretion there by reducing the rate of oxygen consumption in fish (Klein, 1957). Industrial effluent could precipitate on the gill surface (Larson *et al*., 1980) cause accumulation of muddy mucus around the operculum, damage to gill lamellae and degeneration of blood cells in carp species (Sharma *et al*., 1985). Further, this may also due to 'coagulation film anoxia' (Koundinya and Ramamurthi, 1978) in which absorption of oxygen from the surrounding medium is adversely affected (Sastry and Shukla, 1993). Another possible reason for the significant reduction in oxygen consumption beyond 7 days of exposure may be the low level of dissolved oxygen (Sakthivel, 1994) and a heavy load of suspended solids and organic matter (Saxena and Chauhan, 1996) in the tested effluent. The suspended solids and other toxicants could coagulate the respiratory mucus in the gill membrane preventing the absorption of oxygen from the medium (Larson, 1973). The respiratory enzyme system at mitochondrial level could also have been affected by pollutants (Dube and Hosetti, 2010).

In conclusion, the results obtained clearly indicate that textile bleaching effluent is highly toxic as it altered the rate of oxygen consumption following exposure to sub- lethal concentration. Since respiratory rate controls the metabolic activities, altered respiratory rate could have been used as an indicator of stress in effluent exposed organism.

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