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ACUTE TOXICITY OF SUGAR FACTORY EFFLUENT IN *MYSTUS VITTATUS* (BLOCH) : A PROBIT ANALYSIS

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ABSTRACT : This paper deals with the acute toxicity of Sugar factory effluent on freshwater catfish, *Mystus vittatus* (Bloch), at different concentration and duration of exposure on the mortality and ethological alterations. The LC_{50} for 96 hours of sugar factory effluent for *Mystus vittatus* was 3.10% (v/v). The result also revealed that mortality rate depends upon concentrations of effluent and duration of exposure. The effluent exposed test fish showed alterations in behavioural responses. The behavioural alterations of *Mystus vittatus* during the present experiment was found to depend on both duration of exposure and increase in concentration of the effluent and duration of exposure. The mortality rate was found to be directly proportional to the concentration of effluent. Thus, the present revealed that fish, *Mystus vittatus* are sensitive to distillery wastewater and can be used as biological indicators.

Key words : Acute toxicity, ethological responses, *Mystus vittatus*, sugar factory effluent.

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INTRODUCTION

All industries discharge their effluents indiscriminately in the adjoining water bodies and frequently cause serious hazards to aquatic life. Industrial effluents are the major sources of heavy metal pollution that is released into water bodies and causes water pollution worldwide. Deterioration in water quality due to human activities has created a need for developing and adjusting methods for environmental quality. Due to urban, industrial and agricultural activities, freshwater sources are dumped with different kinds of chemicals that affect the inhabiting biota. In order to evaluate the adverse effects of these complex chemical mixtures on aquatic organism, there is a worldwide trend to complement chemical and physical parameters with biomarkers in aquatic pollution monitoring (Van der Oost *et al*, 2003; Au, 2004; Singh, 2021).

The damage caused by any toxicant or pollutant in an organism is called toxicity (Prakash and Verma, 2021; Verma and Prakash, 2021). Toxicity tests are experiments designed to predict the concentrations or doses of toxicant and its duration of exposure required to produce an effect (Cope *et al*, 2004). Toxicity is species-specific because individuals have different levels of response to the same dose of a toxic substance (Smith and Stratton, 1986). Arsenic toxicity in this fish was studied in detail (Prakash and Verma, 2019; Verma and Prakash, 2019a, 2019b).

The toxicity bioassays are used to detect and to calculate the potential toxicological effects of chemicals on organisms. These tests provide a data base that can be used to assess the risk associated with a situation in which the organisms live. A variety of methods have been developed to evaluate the hazard and potential toxicity of chemicals to organisms, such as acute toxicity test, sub-acute toxicity test or chronic toxicity test. Acute toxicity is the severe effect suffered by an organism from short term exposure to toxic chemicals (Koprucu *et al*, 2006). The acute toxicity data are important and beneficial in the fixation of sub lethal concentrations for chronic toxicity tests.

Probit analysis is a type of regression used to analyze binomial response variables and it is commonly used in toxicology to determine the relative toxicity of toxicant or pollutant to living organism (Singh and Zahra, 2017). This is done by testing the response of an animal at different concentrations of toxicant and then comparing

the concentrations at which a response occurs. Probit method is widely accepted and most accurate method for calculating LC_{50}. LC_{50} is the estimation of the dose/ concentration necessary to kill 50% of a large population of the test species.

Fishes have direct economic importance and are quite sensitive to the wide array of pollutants discharged in the aquatic ecosystems. Fishes are widely used to assess water quality of aquatic ecosystems because they serve as pollution bioindicators. Water pollution affects the fish severely and proves lethal to them. Water pollution imposes this adverse effect on all kinds of aquatic flora and fauna. Fishes are mainly affected from the human nuisance. So, it is the need of time to pay adequate attention to this issue and execute necessary corrective measures. Toxicity tests have been performed on fishes to evaluate the effect of industrial effluent under laboratory conditions. To assess susceptibility and survival potential of the test organisms 96hr LC_{50} tests of some particular effluents have been conducted. Therefore, in the present investigation aimed to find out the acute toxicity bioassay and LC_{50} value of sugar factory effluent against a fresh water catfish fish, *Mystus vittatus* calculated by using SPSS software.

MATERIALS AND METHODS

The sugar factory effluent of Balrampur Chini Mills Ltd. was collected from the outlet of effluent treatment plant in sterilized plastic container and brought to laboratory for the experiment. A series of dilutions were made by mixing the effluent with tap water in different glass aquarium. After acclimatization, ten fishes of test fish, *Mystus vittatus* was carefully transferred to the aquarium having effluent of different concentrations. The mortality rates were recorded at regular intervals of 24 hours up to the period of 96 hours. The concentration at which 50% of the test fishes survive after a specified period of exposure is considered as LC_{50} value or median Tolerance limit. Feeding was stopped 24 hours prior to the toxicity test, to minimize the contamination from metabolic wastes. In the present experiment LC_{50} of 48 hours and 96 hours were determined. The LC_{50} was determined by standard methodology (Tiwari and Prakash, 2021) and statistical analysis was done by following SPSS Software.

RESULTS AND DISCUSSION

Acute toxicity test *i.e.* LC_{50} values show susceptibility of fish to particular contaminants and reflect their survival potential. The mortality patterns in relation to sugar factory effluent are presented in Tables 1-3. The relation between percentage mortality and concentration of sugar factory effluent are shown in Table 1 by Finnery's Probit analysis method and in Tables 2 & 3 by SPSS Statistical Software. In the present investigation, the LC_{50} for 96 hours of sugar factory effluent for *Mystus vittatus* was 3.100 at concentration (% v/v) and 1.131 at log concentration 5.0% (v/v) (Table 3). No mortality was taken place in control. Fig. 1 shows the regression line between the log concentration of sugar factory effluent and probit mortality of *Mystus vittatus*.

The effluent exposed test fish showed alterations in behavioural responses during the study period. Initially the fishes showed hyperactivity (rapid jumping and swimming), most of them indulged in surface swimming and they made frequent attempt to leap out of water. It was observed that with the increasing concentration and exposure period these activities were relatively increased. The opercular movements of fishes were very irregular, followed by loss of equilibrium status and finally the movements become feeble, they dropped to the bottom and died. Thus the Sugar factory effluent is toxic to aquatic animals including fishes due to presence of organic, inorganic and metallic substances that caused the alterations in the behavioural responses of fishes. The effluent perhaps induced acute irritation and drastic reduction of dissolved oxygen level in the test aquarium

Table 1 : Survival of fish, *Mystus vittatus* at different test concentrations and sampling intervals.

Conc. (v/v %)	Number of fish exposed	Number of fish died at different time intervals (hours)				Percent mortality upto 96 hours	Table value of probit mortality
		24	48	72	96		
Control	10	0	0	0	0	0	0.0
1.0	10	0	0	0	1	10	3.72
2.0	10	0	0	1	2	20	4.10
3.0	10	0	1	2	4	40	4.75
4.0	10	1	2	3	6	60	5.25
5.0	10	1	3	5	7	70	5.52
6.0	10	2	3	6	9	90	6.28
7.0	10	2	5	7	10	100	8.09

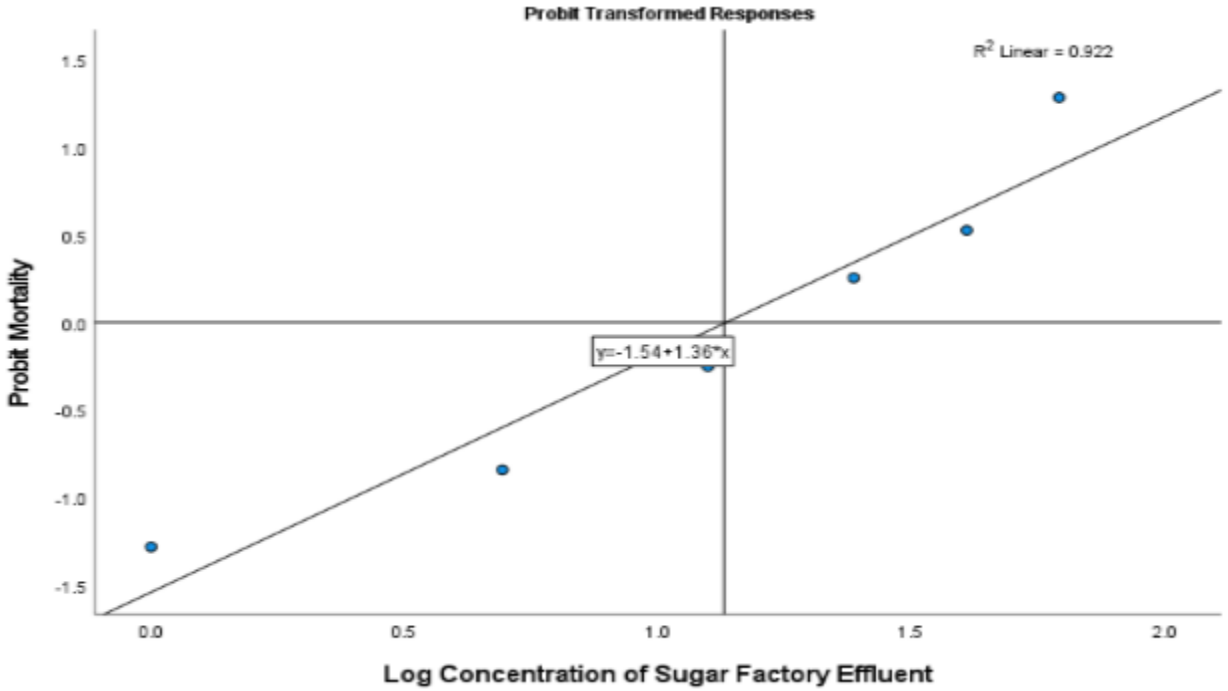

Fig. 1 : Relationship between probit mortality and Log concentration of sugar factory effluent.

Table 2 : 96h LC_{50} of Sugar Factory Effluent for *Mystus vittatus* (Probit analysis by SPSS)

Conc. % (v/v)	Log concentration	Number of fish exposed	Observed response	Expected response	Residual	Probability
1.0	0.000	10	1	0.363	0.637	0.036
2.0	0.693	10	2	2.434	-0.434	0.243
3.0	1.099	10	4	4.792	-0.792	0.479
4.0	1.386	10	6	6.570	-0.570	0.657
5.0	1.609	10	7	7.759	-0.759	0.776
6.0	1.792	10	9	8.526	0.474	0.853
7.0	1.946	10	10	9.019	0.981	0.902

Table 3 : Confidence Limits for Effective Concentration (95% Confidence limits).

Probability	95% confidence limits for concentration			95% confidence limits for Log concentration		
	Estimate	Lower Limit	Upper Limit	Estimate	Lower Limit	Upper Limit
0.50	3.100	2.354	3.869	1.131	0.856	1.353

water leading to behavioural changes and finally death of fishes.

In the present study, the mortality was found to be increasing with increase in exposure period and also with increasing concentration of effluent. Similar observations were found by other workers (Yadav *et al*, 2007; Mishra *et al*, 2011; Prakash and Singh, 2020; Prakash and Verma, 2020; Tiwari and Prakash, 2021). This reflects the regular mode of action, due to harmful xenobiotic of effluent up to dangerous level that cause fish death. The death of fish could be due to the lethal action of effluent that causes changes in metabolic processes. The toxicity of any toxicant for fish depends on species, sex, age, weight, dose or concentration, exposure period, organic or inorganic form etc. (Tiwari and Prakash, 2021). The study suggests that LC_{50} value estimation is a necessary prerequisite to evaluate intensity of toxicity of any industrial effluent, chemicals, heavy metals and pesticides to carry out further studies for estimation of long terms safe concentration and their possible impact on living organisms. From the findings of the present investigation it is evident that sugar factory effluent is toxic in nature and capable to severe damage of tissues of the aquatic animals. Therefore, it is necessary to treat the effluent effectively before release to avoid harmful effect on the aquatic ecosystem.

CONCLUSION

It is concluded that some aquatic animals are sensitive to toxicant present in the factory effluent or in aquatic ecosystem and that cause deleterious effects to them. Fishes are more frequently exposed to these pollutants because it is believed that regardless of where the pollution occurs, it will eventually end up in the aquatic ecosystem. Toxicity studies helps to determine possible limit of a toxicant in an ecosystem and helps to propose policies to protect the aquatic ecosystem.

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