TOXICITY AND BEHAVIOURAL CHANGES IN FRESH WATER FISH *CATLA CATLA* EXPOSED TO AMLAI PAPER MILL EFFLUENT

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Abstract: **Pulp and paper mill, controversially, is one of the largest and major contributors of pollution in aquatic environment, affecting aquatic organisms in general and fishes in particular. Several field and laboratory studies were conducted worldwide on effects of both treated and untreated paper mill effluents on fish. The studies showed wide ranges of toxicity at organismal as well as at population levels. Several workers discussed endpoints of paper mill toxicity in fish ranging from acute and behavioral toxicity, developmental and growth studies. The aim of the present study is to determine lethal concentration for 50% mortality of paper mill effluent to fresh water fish *Catla catla* for 24 to 96 hours using bioassay method. The LC50 values of the prepared concentration for 24, 48, 72 and 96 hrs were found at 11, 10.6, 10.2 and 9.6% respectively. At this concentration, erratic swimming, jerky movement, rapid opercular movement leaping out of water and thick mucus covering over the whole body surface were observed during experiments.**

Keywords: Paper mill effluent Toxicity Behaviour *Catla catla.*

INTRODUCTION

Toxicity test plays an important role to determine the adverse effects on aquatic animals due to varied activities imposed by humans. Toxicity in the medium depends upon several environmental factors like pH, temperature, light, dissolve oxygen, hardness, water flowing pattern and relative humidity. Since the aquatic environment is main sink for all pollutants, these toxicity test having great importance to evaluate the toxic condition and study the behaviour of living organisms.

Globally, pulp and paper industry is considered as one of the most polluting industry [1,2] contributing 100 million kg of toxic pollutants that are being released every year in the environment[3]. In India, the paper industry has been one of the major sources of aquatic pollution [4]. The pulp and paper Industry is one of the oldest industries in this country and there has been tremendous expansion of these industries during the last 25 years. Effluents from pulp and paper mills are highly toxic and are a major source of aquatic pollution. Many chemicals have been identified in effluents which are produced at different stages of papermaking. Their toxic nature is derived from the presence of several naturally occurring and xenobiotic compounds which are formed and released during various stages of papermaking.

The toxicity tests has been historically played an important role in assessing the effect of human activities on animals and such tests have wide applicability in evaluating the toxicities of various types and mixture of pollutant in fish and other aquatic species[5]. The parameters of short-term (toxicity) exposure are the most common measures of toxicity [6-7].

The importance of potential damage to aquatic ecology by effluent has been advocated and demonstrated [8], informing through various toxicity tests used in the management of water pollution as: to estimate environmental effect of waste, to compare the toxicity of different toxicants in animal, to regulate the amount of discharge pollutant [9].

Increase in industrialization currently is underway, but immediate hazard to mankind, domestic animal, fishes and wild life through its wastes is unpredictable. The pulp and paper Industry is one of the oldest industries in our country and there has been tremendous expansion of these industries during last 25 years. Controversially, the paper and pulp industry as it stand now, is one of the largest major Industries and contributes lot towards the pollution in our aquatic environment. Looking in to the serious nature of pollution the pulp and paper industries in India has been brought under 17th categories, is highly polluting industries.

Van Horn [10] reviewed the pulp and paper industry as it affects aquatic biology. Walden [11] published an excellent review on the toxicity of effluents from pulp and paper mills. Reported toxicity of Paper wastes to fish prior the work of Ebeling, [12] in Sweden. Many workers since then have confirmed that concentration of Paper mill effluents needed to kill fish ranged 10 to 100 percent.

The present paper deals with the toxicity and behavioral changes in *Catla catla* exposed to lethal concentration of paper mill effluent

MATERIAL AND METHODS

Fresh water fishes *Catla catla* were collected from Sone River flowing near Amlai Paper Mill Shahdhol M.P. The live fishes were brought to the laboratory and kept in glass aquaria (size3*1*1* ft) under normal conditions for a week. During acclimatization fishes were fed with earthworm pieces. The paper mill effluent was collected directly from the Amlai paper mill industries Pvt. Ltd. Amlai near Shahdhol (M.P). The Physico-chemical characteristics of test water and paper mill effluent have been analyzed during experimentation [13] and the bioassay method [14] to know LC values of effluent. The fishes, *Catla catla* (8 to 8.5 cm in length and 4 to 5.5gm in weight) were selected for LC determination. 50 Preliminary experiments at different percentage of paper mill effluent was conducted to find percentage that resulted in 50% mortality in given time. For experimentation, laboratory acclimatized fishes were exposed to different dilution percentage of paper mill effluents.

The water in test aquaria was changed every 24 hours and was supplied with full aeration. A batch of 10 fishes was also maintained along with experimental fishes as control group. The changes in behaviour of *Catla catla* exposed to effluent were critically observed during the experiment.

Table 1
Showing Physico-chemical Parameter.

Sr. No.	Parameter	Testing Water	Paper Mill effluent
1.	Temperature	26±2 °C	28±2 °C
2	pH	7.4	8.9
3	Dissolve Oxygen mg/l	7.0	0.96
4	Total Hardness (mg/l)	118	1788
5	Alkalinity (mg/l)	33	105
6	Biological Oxygen Demand (mg/l)	9.8	272
7	Chemical Oxygen Demand (mg/l)	2.7	1178
8	Nickel (Ni) (mg/l)	-	0.415
9	Zinc (Zn) (mg/l)	-	0.03
10	Mercury (Hg) (mg/l)	-	0.04

Table 2:
Show % of mortality at different concentrations of paper mill effluent to fresh water fish, *Catla catla*

S. No	Exposure time in hours	LC in % conc.	No. of fish exposed	% of mortality	Regression equation Y =(y-bx)+bx
1	24 hrs	11	10	50	Y= 21.4657 + 25.4385x
2	48 hrs	10.6	10	50	Y= 17.1185 + 21.6510x
3	72 hrs	10.2	10	50	Y= 16.6830 + 24.456 x
4	96 hrs	9.6	10	50	Y= 15.8277 + 21.3678x

RESULTS

Fishes exposed to lethal concentration of paper mill effluent for a short-term exposure were studied in terms of general behaviour, rate of survival and mortality.

The LC50 values of freshwater fish *Catla catla* exposed for 24, 48, 72 and 96hrs have been recorded at 11%, 10.6% and 10.2%. 9.6% dilution of effluent respectively. The LC50 value regression results have been calculated to support present observations in Table 2.

The fish, *Catla catla* when exposed for 24 hrs exhibited abnormal behaviour. It is noticed that at this concentration a sudden terse was laid on the animal, which entailed in erratic swimming, convulsion, jerky movement and rapid opercular movement. The fish struggled hard for breathing some time engulfing atmospheric air and avoided to toxic medium. The fishes were tried to leap out the toxic medium and thick mucus covering over the whole body surface.

DISCUSSION

The freshwater environment is going to be polluted by various pollutants which have adverse effects on aquatic organisms. The freshwater organisms particularly fishes are more susceptible to these pollutants. Since, their habitats are confined and escape from such polluted habitats is impossible.

The effects of pollutants are generally characterized on survival, reproduction or growth due to physiological alteration in the animal. The physical, chemical and biological components of the environment play an important role in manifestation of biological response to pollutants. The toxicity of particular pollutants depend upon many factors such as animal weight [15], developmental stages [16], period of exposure and temperature, pH, hardness of water and dissolved content of the medium, [17-18].

The response of animal to toxic medium is important since it reflect the internal changes. Muley and Karanjkar [19] reported the electroplating effluent was more toxic than that of tannery and textile wastes and imposed the disability in test fish *Labeo rohita*. The treated fishes were shown adverse effects on body treated fishes were shown adverse effects on body posture and colour i.e. it turns pale white with opened mouth on toxicity of organophosphate manifested by inhibition of AchE [20]. On exposure to Nuvan in *Clarias batrachus* show significant change in opercular movement, locomotory, behavioural as well as body colour were observed [21]. Bhattacharya and Mukherjee [22] reported that the industrial effluent affect normal vision, proper body motion and behaviour of the organism.

During present study fish, *Catla catla* showed hyper excitation, erratic swimming, convulsions jerky movement and rapid opercular movement and thick mucus covering over the whole body surface. Similar results were observed by Srivastava *et al.*, [23] when *Labeo rohita* and *Channa punctatus* exposed to paper mill effluent.

Rajendra Kumar *et al*, [24] reported the toxicity of paper mill effluent to fish *Puntius sophor*. Tests were conducted in two groups. In first group dilution were aerated. Where, as in group second dilutions were not aerated. LC50for 96 hour was estimated at 1.5% whereas in second test it was recorded at 16.5%. Varadaraj and Subramanian [25] reported the toxicity of paper and pulp mill effluent to fingerlings of

Oreochromis mossambicus and reported LC50 for 96 hrs. The 96 hrs LC50 value of paper and pulp mill effluent was 6% respectively. Nanda *et al.,* [26] studied toxicity of paper mill effluent. The LC50 values were found at 63.09, 80.35 and 8128 % for *Anabus testudineus, Channa punctatus and Clarias batrachus* respectively. This indicates that *Anabus testudineus* is most susceptible, while *Channa punctatus* and *Clarias batrachus* were resistive.

Stalin et al, [27] calculated the LC50 of synthetic pyrethroid deltamethrin and a Neem based pesticides, azadirachtin to *Poecilia reticulata.* The 96 hrs LC50 value of deltamethrin was 0.0019 and azadirachtin was 0.011 mg/l.

In the present study the LC50 values were calculated for different concentration of effluent for 24 to 96 hrs. exposure period. The data indicate that decrease in LC50 concentration is associated with increase in duration of exposure. Toxicity of the effluent mostly depends on the uptake of the effluent by the body. The rate of uptake is determined by the ratio of the permeability of body surface in contact with the medium to volume or weight of exposed animal and similar with relationship persists between the rate of metabolism and weight of animal [28].

During the estimation of LC50 value for survival rate of *Catla catla* was decreased as increase in the concentration of paper mill effluent. The exact cause of death is ill defined as there are number of channels. The death may be the result of severe physiological stress at cellular level. The physiological stress may be responsible for the death of fish [29].

It is also noticed that, the toxicity of the paper mill effluent is attributed synergistically to the physical factors of medium i.e. high COD and BOD values besides low pH and low dissolved oxygen (DO).

CONCLUSION:

Pulp and paper mills seem to pose great risk to fish species in terms both acute and chronic effects. Thus it is concluded that the effluent is not safe to non-target organisms like fishes. This type of study can be useful to compare the sensitivity of various species of aquatic animals and potency of effluent using LC values and to derive safe concentration. Changes in behaviour of fish, *Catla catla* due to paper mill effluent stress can be used as a biological indicator of pollution as biological early alarm system of the paper mill effluent.

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