

Toxicity and Behavioral Changes in Freshwater Fish *Tilapia* Exposed to orient Paper Mill Effluent

¹Neha Pandey, ²Vandana Agrawal and ³Deepak Sinha

¹Govt. S. K. N. PG. College, Mauganj, Rewa(M.P.)

^{2,3}Govt. N. PG. College of Science, Raipur (C.G.)

Abstract: The aim of the present study is to determine lethal concentration for 50% mortality of paper mill effluent to fresh water fish *Tilapia* 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.

Index Terms - Paper mill effluent, Toxicity Behavior, *Tilapia*.

I. INTRODUCTION

Acute 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 (Craddock, D. R.,1977). The parameters of short-term (toxicity) exposure are the most common measures of toxicity (Cowell *et al.*, 1972, Krebs and Burns, 1977).

The importance of potential damage to aquatic ecology by effluent has been advocated and demonstrated (Sprague, J. B. 1969), 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 (Buikema *et al.* 1982).

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, W. M. (1961), reviewed the pulp and paper industry as it affects aquatic biology. Walden, C. C. (1976) 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, G. (1931) 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 *Tilapia* exposed to lethal concentration of paper mill effluent.

II. MATERIAL AND METHODS

Fresh water fishes *Tilapia* were collected from Sone River flowing near orient Paper Mill Shahdhol M.P. The live fishes were brought to the laboratory and kept in glass jar under normal conditions for a week. During acclimatization fishes were fed with earthworm pieces. The paper mill effluent was collected directly from the orient paper mill industries Pvt. Ltd. The Physico-chemical characteristics of test water and paper mill effluent have been analyzed during experimentation APHA (1992) and the bioassay method (Finney, D. J. 1971) to know LC values of effluent. The fishes, *Tilapia* 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 behavior of *Tilapia* exposed to effluent were critically observed during the experiment.

III. RESULTS

Fishes exposed to lethal concentration of paper mill effluent for a short-term exposure were studied in terms of general behavior, rate of survival and mortality. The LC50 values of freshwater fish *Tilapia* exposed for 24, 48, 72 and 96 hrs have been recorded at 12%, 11.6% and 12.2%. 10.6% dilution of effluent respectively. The LC50 value regression results have been calculated to support present observations in Table 2.

The fish, *Tilapia* when exposed for 24 hrs exhibited abnormal behavior. 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.

Table 1 Showing Physico-chemical Parameter.

Sl. No.	Parameter	Testing Water	Paper Mill effluent
1.	Temperature	26±2 °C	30±2 °C
2	pH	7.4	6.4
3	Dissolve Oxygen mg/l	7.0	0.76
4	Total Hardness (mg/l)	118	632
5	Alkalinity (mg/l)	33	76
6	Biological Oxygen Demand (mg/l)	9.8	171
7	Chemical Oxygen Demand (mg/l)	2.7	123
8	Nickel (Ni) (mg/l)	-	0.315
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, *Tilapia*.

Sl. 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	$Y= 15.8277 + 21.3678x$

IV. 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 (Pickering, Q. H. 1968), developmental stages (Kamaldeep and Joor, 1975), period of exposure and temperature, pH, hardness of water and dissolved content of the medium, (Mc leese, D. W. 1974, Brungs *et al.*, 1977).

The response of animal to toxic medium is important since it reflect the internal changes. Muley and Karanjkar (2004) 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 posture and colour i.e. it turns pale white with opened mouth on toxicity of organophosphate manifested by inhibition of AchE (Vasalt and Patil, 2005). On exposure to Nuvan in *Clarias batrachus* show significant change in opercular movement, locomotory, behavioral as well as body colour were observed (Trivedi and Sexsena, 1999). Bhattacharya and Mukherjee (1978) reported that the industrial effluent affect normal vision, proper body motion and behavior of the organism.

During present study fish, *Tilapia* showed hyper excitation, erratic swimming, convulsions jerky movement and rapid opercular movement and thick mucous covering over the whole body surface. Similar results were observed by Shrivastava *et al.*, (2007) when *Labeo rohita* and *Channa punctatus* exposed to paper mill effluent.

Rajendra Kumar *et al.* (1991) 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. LC50 for 96 hour was estimated at 1.5% whereas in second test it was recorded at 16.5%. Varadaraj and Subramanian (1991) 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.*, (2002) 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.

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 (Bertalanffy, V. L. 1957).

During the estimation of LC50 value for survival rate of *Tilapia* 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 (Abel and Skidmore, 1975).

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).

V. CONCLUSION

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 behavior of fish, *Tilapia* 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.

VI. ACKNOWLEDGMENT

Authors are grateful to, Dr. Devendra N. Pandey Prof. Department of Zoology, Govt. S. K. N. PG. College, Mauganj Rewa (M.P.) India for provision of laboratory facilities during experimentation.

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