IMPACT OF INDUSTRIAL EFFLUENT ON THE CHANGES IN BEHAVIOUR AND BODY WEIGHT OF A FRESH WATER FISH, Oreochromis mossambicus, Peters.

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ABSTRACT

One must continue to anticipate increasing density of urban population with all the problems of air, water pollution and waste disposal. The most important thing is the introduction of chemical substances into the environment, which never before existed in nature. Emissions of effluent from various industries into water bodies are having detrimental effects on aquatic species like fish. High percentage of mortality of fish due to the action of the effluent might be due to the pathological changes. The present investigation was designed to study the effect of effluent of a chlor-alkali industry on behaviour & body weight of a fresh water fish, Oreochromis mossambicus, Peters and its toxicological significance. The MAC value of the effluent was found to be 6.41 ml/l for 30 days and to be on the safer side 6.0 ml/l was considered for 28 days of the exposure for sub-lethal toxicological studies. The LC_{10}, LC_{50}, LC_{100} values after 28 days were recorded. It has been observed that all the exposed fishes appeared lethargic after exposure to the effluent. The major clinical symptoms such as inappetance and ataxia appeared immediately after exposure. At higher concentration, the exposed fish showed loss of equilibrium, gradual onset of inactivity, erratic swimming with irregular collision to the inner glass wall of the aquarium were observed. Infection of eyes, exophthalmia and involusions of test fish were observed, when compared to control fish. The body weight showed a linear increase showing the existence of significant positive correlation with the exposure period in the control set. Body weight of the control fish increased by 1.26 % on 7th day of exposure, by 3.65 % on 14th day of exposure. On 21st day of exposure 7.24 % increase in body weight was marked. On 28th day of exposure, 9.25 % increase was recorded. Whereas, a significant negative correlation was observed between the exposure period and body weight. With the increase in exposure period, the body weight significantly declined. The body weight of the exposed fish gradually decreased during the exposure period and On 7th day of exposure 7.2 % decrease, on 14th day of exposure, 14.96 % decrease, on 21st day of exposure 25.06 % decrease, on 28th day of exposure, 31.89 % decrease was recorded, when compared to its respective control values. Control fish did not show any signs of toxicity. No recovery in body weight was marked, when the exposed fish was transferred to effluent free normal medium for recovery studies, instead of showing any recovery, 47.96 % decrease was recorded on 28th day of recovery.

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Key Words: *Fish, Chlor-alkali industry, Effluent, Toxic effect, Behaviour, Body Weight*.

INTRODUCTION

The two most important processes that effect the global environment are the resource production and the waste disposal. A proper balance between these two is necessary for a healthy biosphere. Although, certain resources are often created for some useful purpose, on actual use some such resources contaminate and pollute the environment. Besides, every human society, be it rural or urban, industrially or technologically advanced, disposes certain by-products and waste products into the environment, Patro (2006).

Mushrooming of industries throughout the world to cater to the needs of the growing population and technology has resulted in the use and production of a large number of chemicals. These chemicals include extremely toxic substances which can affect man and other living bodies in the ecosystem severally Patro (2007).

Shaw (1987) reported a detailed account pertaining to the grave situation the Rushikulya river estuary was facing because of the effluent discharge from a ehler-alkali industry. Choudhury (1992 and 1993) reported the effect of solid waste and the leached chemicals of the solid waste of the Chlor-alkali industry on freshwater fishes. Panigrahi & Misra (1978, 79, 80) and Panigrahi (1980) studied in details about the effect of mercurial compounds on the behaviour, physiology, haematology, and on the macromolecules of freshwater fishes. No information was available on the direct effect of the effluent of the industry on freshwater fishes. The effluents of the industry leach and enter into neighbouring ponds and contaminated the ponds, where this Tilapia fish (*Oreochromis mossambicus*) was mass cultured. Hence, this project was designed for instant information on the issue.

MA TERIALS AND METHODS

Oreochromis mossambicus, Peters of medium size (30-35 gm) were collected from the local nursery of the Fisheries Department of Berhampur, Odisha. The fish were allowed to grow in the laboratory reservoirs for acclimatization at least for 15 days before starting the experiment. The fish were maintained in aquarium of 60 x 58 cm. containing 70 liters of water. Chlorine - free tap water was used in both control and experimental aquarium. The water was changed daily. Air was bubbled through water of, the aquarium to maintain the dissolved oxygen at 85 ±. 5 % air saturation value. The physico-chemical quality of the water of both control and exposed aquarium were measured during the experimental period. (A.P.H.A., 1974) and maintained at the same level. Living earthworms from garden showing no contamination by pesticides were collected and fed daily to both control and exposed fish initially and slowly the diet was changed to pesticide-free chopped goat liver and then to small slices of boiled eggs during holding and through out the experimental exposure period. After acclimatization, the fish were washed thoroughly with 1 % dilute potassium permanganate ($KMn0_4$) solution, so as to prevent any infection. The test solution of the experimental aquarium was changed daily so as to maintain the constancy of the toxicant concentration. The experimental aquarium was washed thoroughly to remove any amount of toxicant adhered to glass surface. Exposed fish were observed daily to record any change in behaviour compared to control fish. The test fish exposed to lower range of the effluent were exposed for a period of five weeks to find out the maximum allowable concentration (MAC), where no mortality was noticed and this was expressed as ml^{-1}. Different values such as LC_{10}, LC_{50}, and LC_{100} were deduced from graphical interpolation (Finney, 1977). .

During the acute toxicity studies fish were observed for behavioral changes influenced by the effluent containing mercury collected from a chIor-alkali industry. Experimental fishes were sacrificed; brain and liver were dissected out carefully and washed thoroughly with distilled water. The sacrificed fishes were weighed. Brain and liver were separated and weighed carefully in a single pan electric balance and the different somatic indices were calculated. The individual changes in body weight of both control and experimental fish were noted at 7-day interval and the percent change in body weight was computed.

RESULTS

The result showed that the MAC value of effluent was found to be 6.41 m1 l^{-50} for 30 days and to be on the safer side 6.0 m1 l^{-50} was considered for 28 days of the exposure (Tab I) for sub-lethal toxicological studies. The LC_{10}, LC_{50}, LC_{100}. Values after 28 days were recorded to be 9.22, 12.36, 23.54 m1 l^{-50} of the effluent No mortality was observed in the control set.

Table -1. Toxicity study data .

Exposure period 30 days	
MAC	6.41 $ml.l.^{-50}$
Used concentration	6.0 $ml.l.^{-50}$
LC Value after 30 days of exposure	
LC_{10}	9.22 $ml.l.^{-50}$
LC_{50}	12.36 $ml.l.^{50}$
LC_{100}	23.54 $ml.l.^{-50}$

All the exposed fish appeared lethargic after exposure to the effluent. The major clinical symptoms such as inappetance and ataxia appeared immediately after exposure. At higher concentration of the effluent of the industry, the exposed fish showed erratic movements. The other signs of toxicity such as loss of equilibrium, gradual onset of inactivity, erratic swimming with irregular collision to the inner glass walls of the aquarium were observed. Infection of eyes, exophthalmia and involusions of test fish were observed. Exposed fish could not regain their pre-exposed activity after transferring the exposed fish to effluent free water in recovery studies.

Body weight of the control fish increased by 9.25 % after 28 days and by 18.65 % after 56 days. Whereas, the body weight of the exposed fish gradually decreased during the exposure period and a maximum of 22.64 % decrease was observed after 28 days of exposure (Fig. 1 and Tablc- 2), when compared to control fish. Control fish did not show any signs of toxicity. No recovery in body weight was marked, when the exposed fish was transferred to effluent free normal medium. Rather further depletion by 6.7 % over the 28 d exposure value was marked. The two way analysis of variance ratio test conducted on the basis of Table - 2 data, related to body weight of the control and exposed fish, indicated the existence of nonsignificant difference between rows, and columns. The body weight showed a linear increase showing the existence of significant positive correlation ($r = 0.983$, $P \leq 0.001$) with the exposure period in the control set. Whereas, a significant negative correlation was observed between the exposure period and body weight.

With the increase in exposure period, the body weight significantly ($r = -0.986$, $p \leq 0.001$) declined (Fig. 1). The control fish showed 1.26% increase in body weight on 7th day of exposure. The body weight increased by 3.65 % on 14th day of exposure. On 21 st day of exposure 7.24 % increase in body weight was marked. On 28th day of exposure, 9.25 % increase was recorded. However, in case of exposed fish, significant decrease in body weight was recorded. On 7th day of exposure 7.2 % decrease, when compared to control was marked. On 14th day of exposure, 14.96 % decrease was recorded. On 21st day of exposure 25.06 % decrease, when compared to control was marked. On 28th day of exposure, 31.89 % decrease was recorded, when compared to its respective control values. When the exposed fish was transferred to toxicant free medium for recovery studies, instead of showing any recovery, 47.96 % decrease was recorded on 28th day of recovery (Table-2. and Fig.2. and 4).

DISCUSSION

Long term sub-lethal effects resulting from chronic exposure of organisms to lower levels of toxicants probably have the most important effect on the aquatic organisms. Effluent in the aquatic environment was recognized 2-3 decades back as a serious problem. A good number of workers dealt this problem to find out the impact of different types of effluents on aquatic flora and fauna. Panigrahi (1980) reported the behavioral changes observed in inorganic mercury exposed fresh water fishes. Panigrahy (1984) reported that fishes showed a change in behavior when exposed to Emisan-6 (MEMC). Macleod and Passah (1973) reported the behavioral changes induced by mercury in Rainbow trout. Larson (1970) reported metabolic effects of starvation in the eel, Anguilla Anguilla L., Gibilin and Massaro (1973) observed behavioral changes induced by methyl mercury in Rainbovi trout Sto ke et al. (1973) reported changes in body weight, kidney and liver weight in Japanese quail induced by lead. Bhatia et. al. (1973) reported behavioral changes induced by dieldrin in albino rats.

The mortality percentage for any fixed period increased with the increasing concentration of the effluent. There was an increase in mortality percentage with the increase in exposure period also. The proportion of these animals that died in a fixed time increased with the Increase in the eff1uent concentration and the median tolerance limit value decreased with the exposure period (Das and Mishra- 1982 and Panigrahi. 1984). The route of entry of the effluent is generally agreed to be via the gills (Holden, 1974; Samant, (1989), Ferguson et al., 1966) and thus enters directly into the circulatory system. This caused damage to tissues as a result of which there is depression in active metabolism (Macleod and Passah, 1973). Depression in active metabolism that directly reduced scope of activity was demonstrated by Fry (1957). Probably this has relevance with the impaired swimming ability, erratic movements, paralysis, and ataxia which were observed in all test fish at higher exposure periods.

High percentage mortality of fish due to the action of effluent might be due to the pathological changes, as Mathur (1969) pointed out that fish subjected to insecticides such as lindane, dieldrin, DDT and BHC die due to pathological disorders. Choudhury (1980) showed the organochloro insecticides were highly toxic to fish even at very low concentrations Ray and David (1962) concluded that deficiency of dissolved oxygen concentration caused by decomposition of algae or bottom deposits was mostly the cause of the fish kills in ponds and impounded water. Inorganic ions can equally prove fatal by limiting oxygen intake causing respiratory and circulatory failure influencing smooth osmotic exchange of gases caused by flocculation of iron on gill filaments. David et aI., (1976) showed that of the metals tested, silver and mercury were the most toxic i.e., silver was 95% toxic at 0.086 ppm and mercury at 0.150 ppm, while LC_{50} values were 0.033 ppm for silver and 0.089 ppm for mercury. During the experimental period temperature, hardness, time of exposure size of the test-fish and all such factors were monitored since the interference of one of these factors will alter the TLM values and MAC values.

Hence, with the recognition that all types of effluents / pesticides are potentially lethal to fish even at relatively low concentrations. It is now a normal practice to test all new chemicals for their toxicity to fish. The LC_{50} and MAC values can be helpful to understand about the amount of pesticide needed for agricultural use and the amount and concentration of the effluent to be discharged that would have no side effect on other non-target / target organisms like fish.

CONCLUSION

Chlor-alkali plants are widely accepted as a potential industrial emission of mercury (Flewelling, 1971). This dragged my attention to the environmental problem caused due to build up of mercury at various zones of the Rushikulya river mouth to which the effluents of a chlor-alkali factory are released. A high level of mercury concentration I noticed in water and sediment. The fishes collected from the river and estuary indicated very high level of mercury in brain, liver and muscle samples of the fish. The effect of the effluent of the factory and the leached chemicals of the solid waste dump, on the estuarine fish was studied and reported. Estuarine fish was collected but these fishes could not survive longer (less than 15 minutes). Hence, it was not possible to study the effect of these chemicals on the whole body respiration or on ventilation rate. Hence, the present experimental study was designed to study the effect of the effluent of the chlor-alkali industry on a freshwater fish.

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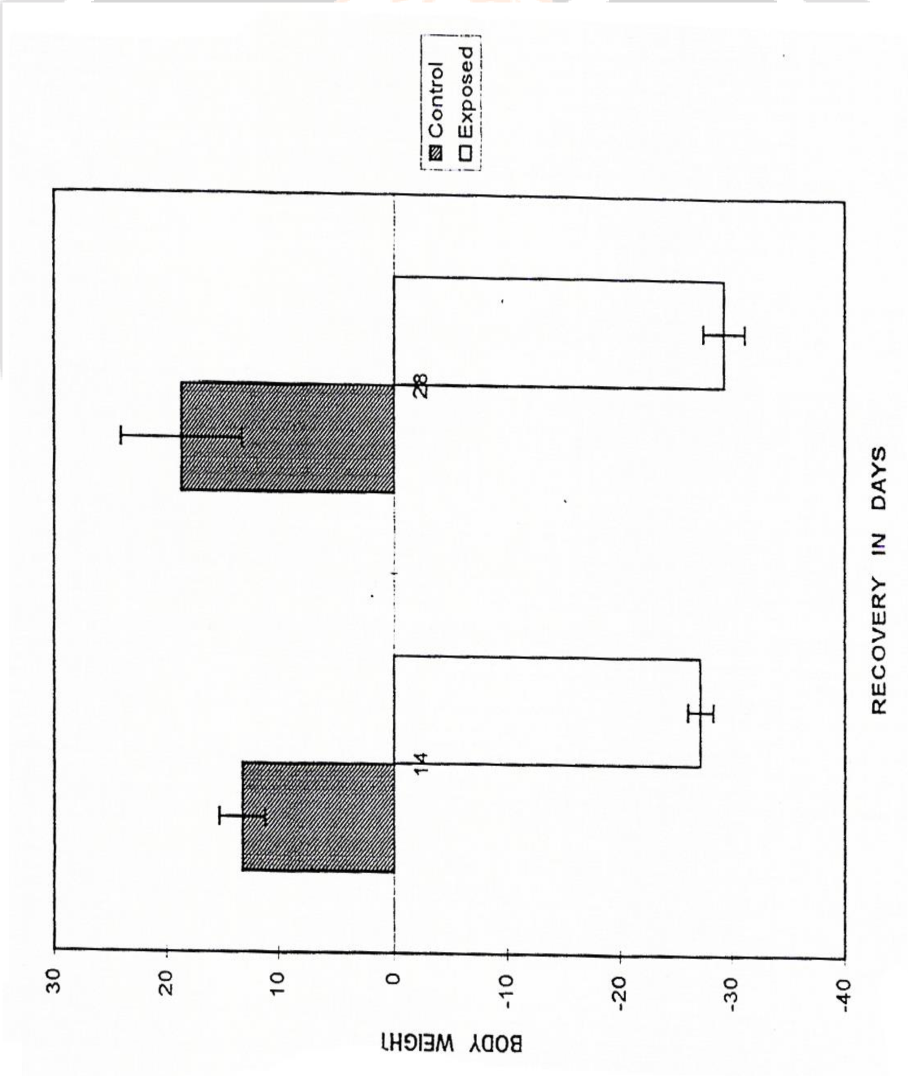


Fig. 2. Showing change in body weight of the control and effluent exposed fish at different days of recovery .

Fig. 1. Showing changes in body weight of the control and effluent exposed fish at different days of exposure.

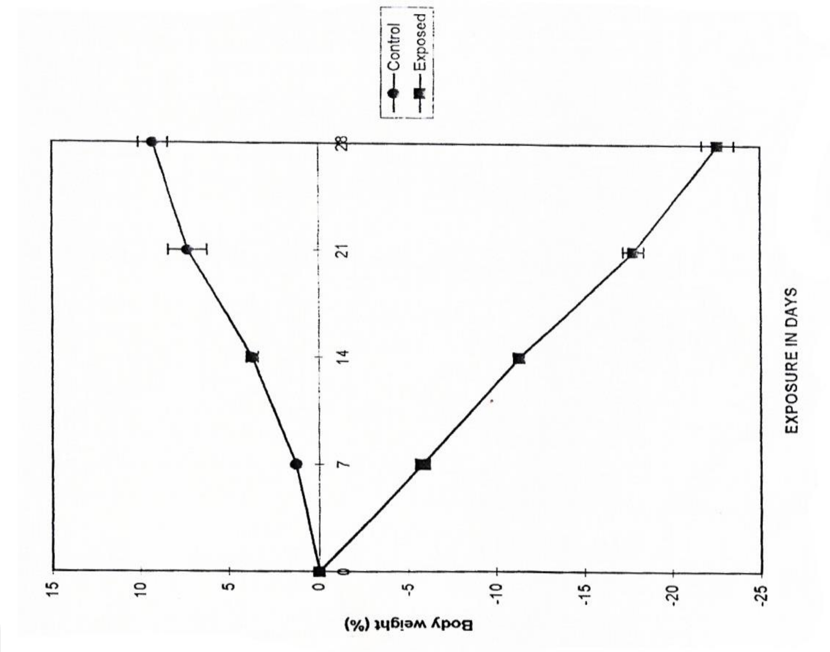
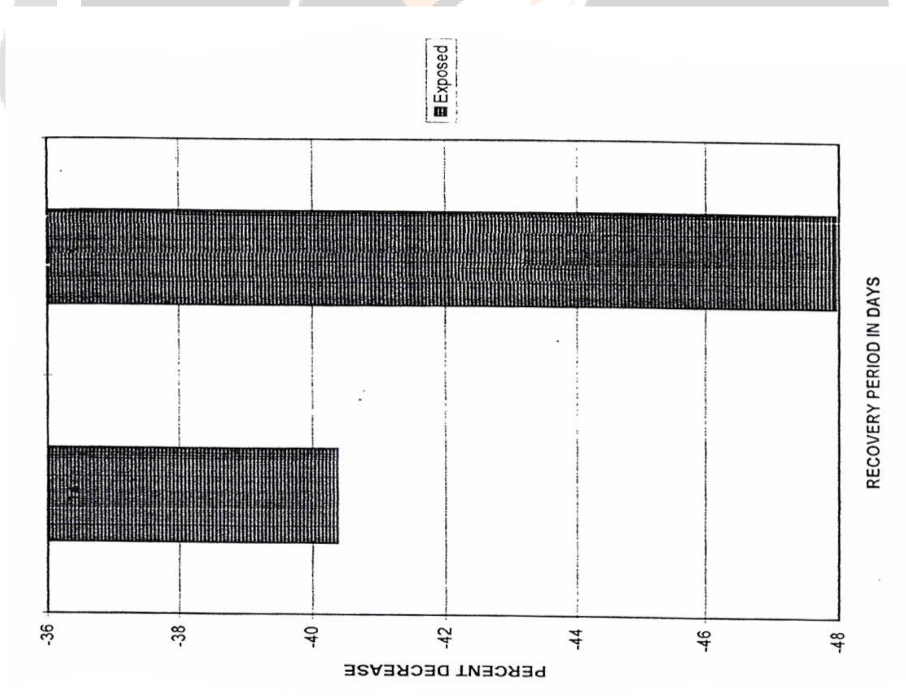
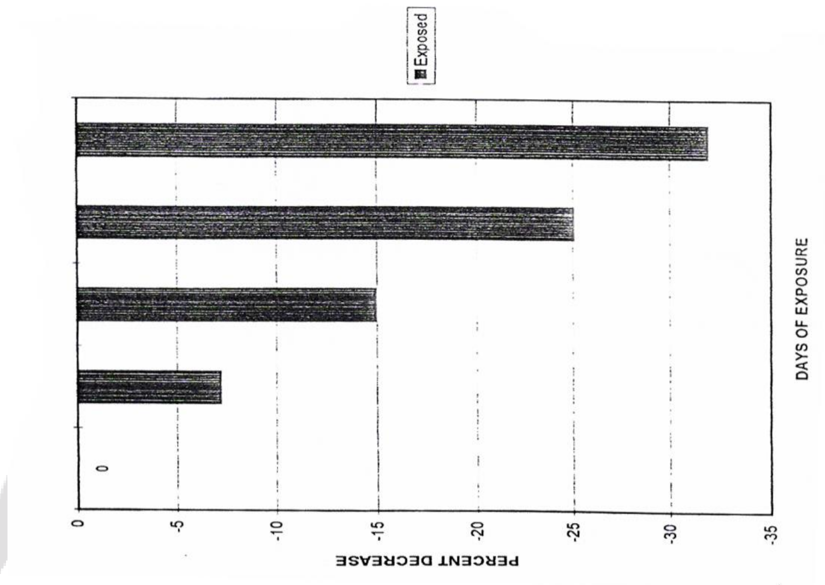


Fig.4. Percent change in body weight in the dffluent exposed fish during recovery periods.





Fig, 3. Percent change in body weight in dfluent exposed fish , when compared to control, at different days of exposure.

Table - 2. Shows changes in body weight (%) in control and effluent exposed fish at different days of exposure and recovery. Values in parentheses indicate percent change in body weight in exposed fish, when compared to control fish.

Status	EXPOSURE PERIOD IN DAYS Body weight in %					RECOVERY IN DAYS Body weight in %	
	0	7	14	21	28	14	28
Control	0.0	1.26	3.65	7.24	9.25	13.2	18.65
Exposed	0.0	-5.85	-11.31	-17.82	-22.64	-27.2	-29.31
% change	No change	(-7.20)	(-14.96)	(-25.06)	(-31.89)	(-40.40)	(-47.96)