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# Studies on the bioaccumulation of lead in *Oreochromis mossambicus* during short term toxicity

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**Abstract**
The present study was conducted to determine heavy metal concentrations in various tissues of gills, liver and muscle from the selected fresh water fish *Oreochromis mossambicus.* The fishes were exposed to sub lethal concentrations of lead acetate for 96 hr and $LC_{50}$value was found to be 18.7ppm. One -tenth of (1/10) $LC_{50}$ (1.87 ppm) value was selected as lower sub lethal concentration for a period of 30 days. The fish organs viz., gills, liver and muscle from the selected fresh water fish was carefully dissected for determination of heavy metal using ELICO's SL – 176 double beam Atomic Absorption Spectrophotometer (AAS). The results revealed that the presence of even (1.87 ppm) low concentration of lead accumulation exhibits a maximum level in liver (0.720 ± 0.0027 µg/g), gills (0.611 ± 0.0036 µg/g) and muscle (0.249 ± 0.0041 µg/g) tissues of 30 day exposed fish. The result of the present investigation reveal a time dependent lead accumulation in the different tissues of fishes exposed to different periods of sub-lethal concentration of lead. These findings extend for future studies on the evaluation of lead accumulation tendency in relation to the ecotoxicological examining programme for risk assessment.

**Keywords:** Fish, Lead, 96 - h $LC_{50}$, Lethal concentrations, Metal accumulation

## 1. Introduction
Increasing environmental pollution, especially the contamination of pond water due to industrial wastes and pesticides and other pollutants from agricultural lands affects ecological balance (Holden, 1972) [8]. Heavy metal contaminants in aquatic ecosystems pose a serious environmental hazard because of their persistence and toxicity. Recently increase in the concentration of heavy metals (Cd, Cu, Fe, Ni, Pb and Hg) have been reported in water of Vasai Creek, Maharashtra (Loakhande and Kolker, 1999) [13]. Aquatic organisms are in great danger due to the pollution of heavy metals like lead. The uptake and accumulation of lead by fishes have been documented by Sindayigayn *et al*., (1994) [19]. Lead present in water is known to be highly toxic to fishes. Bioaccumulation and biomagnifications are capable of leading to toxic levels of metals in fish, even when the exposure is low. Due to deleterious effects of metals on aquatic ecosystems, it is important to monitor the bioaccumulation of metals in an aquatic system. This will give an indication of the temporal and spatial extent of metal accumulation as well as an assessment of the potential impact on human health and organism health. The bioaccumulation of metal toxicants depends on availability and persistence of the contamination in water, food and physicochemical properties of the toxicants. Fishes are known for their ability to concentrate heavy metals in their muscles and various organs. Vinodhini and Narayanan (2008) [23] pointed out that the gills, skin and digestive tracts are potential sites of absorption of water borne Chemicals. Misra *et al*., (2002) [15] have reported the accumulation of various heavy metals in grass carp. The bioaccumulation of heavy metals in fresh water fishes were studied by Pazhanisamy, (2002) [17] and Zyadah and Abdel Baky (2000) [24]. Bioaccumulation is the net build-up of substances from water in an aquatic organism as a result in an aquatic organism as a result of enhanced uptake and slow ejection of substances (Bhattacharya *et al*., 2008) [2].

## 2. Materials and Method
Freshwater fish *Oreochromis mossambicus* ranging from 10 -12 cm in length and weighing between 20-25g were collected fish farm located in Annaikkarai, Kumbakonam, Tamil Nadu and was acclimatized under laboratory conditions (29±1ºC).

The fish were fed daily on oil less groundnut cake. The unused food was removed after two hours and water was changed daily. Prior to experimentation *Oreochromis mossambicus* were acclimatized in experimental tanks for at least one week. The $LC_{50}$ values were determined by Finney (1971) [5] which were found to be 18.7ppm. Sub-lethal studies are helpful to assess the response of the organism under augmented stress caused by metals. According to Konar (1969) [11] and Sprague (1971) [21] one –tenth (1.87 ppm) of the 96 hr $LC_{50}$ values of lead acetate were selected for the present investigation as sub-lethal concentration respectively.

## 3. Results

The accumulation of lead was found in various tissues (Liver, Muscle and Gill) of *Oreochromis mossambicus* exposed to sub-lethal exposure of lead for different intervals of 10, 20 and 30 days (Table-1). The concentrations of lead in different tissues of Oreochromis mossambicus are found to be maximum at 30 days of sub lethal exposure period. In the fish treated with sub-lethal concentration of lead for 30 days the bioaccumulation of lead in the liver 0.222, 0.384 and 0.720 µg/g of tissues for 10, 20 and 30 days exposure periods respectively. The accumulation of Lead is gradually increased from 10-30 days in the tissues of liver, gills and muscle of *Oreochromis mossambicus* exposed to sub-lethal concentration of Lead. In the treated fish the mean lead accumulation in the muscle tissues were 0.067, 0.157 and 0.249µg/g of tissue whereas in gills were 0.104, 0.278 and 0.611 µg/g. The bioaccumulation of lead in the liver was 0.222, 0.384 and 0.720 µg/g. The Lead accumulation exhibits maximum level in liver (0.720µg/g) followed by gill (0.611µg/g) and muscle (0.249 µg/g) for a period of 30 days sub-lethal exposure (Fig.1).

**Table 1:** Accumulation of lead among different tissues of *Oreochromis mossambicus* exposed to sub-lethal concentration of lead.

| Tissues | Tissue concentration of lead µg/g | | | |
|---|---|---|---|---|
| | Exposure period in days | | | |
| | Group | 10 | 20 | 30 |
| Muscle | C<br>SL | ND<br>0.067 ± 0.0072 | ND<br>0.157 ± 0.0052 | ND<br>0.249 ± 0.0041 |
| Gill | C<br>SL | ND<br>0.104 ± 0.0042 | ND<br>0.278 ± 0.0073 | ND<br>0.611 ± 0.0036 |
| Liver | C<br>SL | ND<br>0.222 ± 0.0031 | ND<br>0.384 ± 0.0014 | ND<br>0.720 ± 0.0027 |

C – Control, SL - Sub-lethal concentration, ND - Not- Detected, Mean ± S.E indicates the mean of six individual observations.

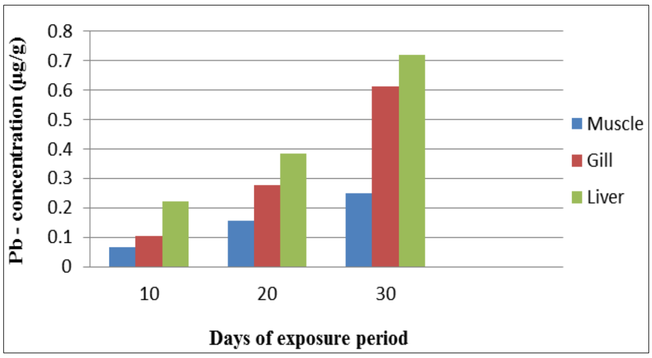


**Fig 1:** Concentration of lead in fish sample

## 4. Discussion

In the present investigation, the highest level of lead accumulation was found in the liver when compared to other tissues, followed by gill and muscle tissues of *Oreochromis mossambicus*. When exposed to sub-lethal concentration of lead for time intervals. These findings recorded that liver is prime site of metal binding in fresh water fishes. Lead acts as a cumulative poison. Lead accumulation in *Anabas testudineus* showed typical differences with a high degree of organ specificity after 30 days exposure to sub-lethal concentration of lead (Tulasi *et al*., 1992) [22]. In aquatic ecosystem availability of heavy metal depends mostly on the geochemical nature of the system. Metals occur naturally in water and many of them such as Cu, Co, Fe, Mn, Ni and Zn are used for essential purpose by aquatic organism. The available heavy metals are in turn absorbed by the plants and aquatic weeds from the water (Misra *et al*., 2002) [15].

Measurement of lead residues to assess bioaccumulation of lead in different fresh water fishes during induced and field exposure has been attempted by Shastry and Shukla (1993) [18]. In the present study the accumulation of lead occurred in the following order Liver > Gill > Muscle in sub lethal concentration of lead at all exposure periods 10, 20 and 30 days. Similar findings were also been reported by Ibemenuga and Keziah Nwamaka, (2013) [9]. Misra *et al*., (2002) [15] have assessed the heavy metal concentration like Mn, Pb, Cu, Cr, Ni, Zi in *Grass carp, Ctenopharyngodon idella*. The metal concentration in the liver which plays a major role in detoxification as well as storage would therefore differ from the concentration detected in the gills and skin tissue which play a role in the uptake and excretion of the metal (Kotze *et al*., 1999) [12]. Heath (1987) [7] and Seymore (1994) [20] have observed the higher level of accumulation in the liver tissue than muscle and gill tissues of fresh water fishes. Akan *et al*., (2009) [1] have reported that absorbed toxicants are transported through the blood to either a storage point like bone or to the liver for transportation.

The differences in the levels of accumulation in the different organs/tissues of fish can primarily be attributed to the differences in the physiological role of each organ with the increase in exposure period the residual lead accumulation showed on increasing trend. Hence it can be suggested that lead enriches in the tissues of the fish have been reported by Jagadeesan (1994) [10] in *Labeo rohita*. Gills are the primary site for accumulation of heavy metals in *Oreochromis mossambicus* is a finding that is in agreement with the result of Gupta *et al*. (1988) [6]. Eaton (1974) reported that highest levels of cadmium in liver and gills were found in the long term exposed blue gills. Vincent and Ambrose (1994) [22] have found that 10 and 20 days exposed fish gills accumulated maximum cadmium followed by kidney. The route of entry of the toxicants is generally agreed to be via the gills (Holden 1962; Ferguson *et al*; 1966) [8, 4] and thus enter directly into the circulatory system. This causes damage to tissues as a result of which there is depression in active metabolism (Mac Leod and Passah, 1973) [14]. The present findings clearly emphasized that lead is accumulated primarily in major organ tissues of fish rather than in muscle. Similarly Osman *et al*., (2007) [16] has also reveals that the heavy metals like Zi, Cu, Pb, Cd, Cr and Hg are possibly unfavourable to most organisms even in very low concentrations and have been announced as dangerous environmental toxins able to accumulate through the aquatic food cycle with serious risk for animal and human health. The results of the present investigation indicated that the rate of accumulation of lead was found to be time dependent.

## 5. Conclusion

The results of the present investigation reveal a time dependent lead accumulation in the different tissues of fishes exposed to different periods of sub-lethal concentration of Lead. It is clear that lead accumulation is highly variable and inconsistent in freshwater fishes depending up on availability and persistence of this contaminant in the medium. These findings extend for future studies on the evaluation of lead accumulation tendency in relation to the ecotoxicological examining programme for risk assessment.

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