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Assessment of Physico-Chemical Parameters and Accumulation of Heavy Metals in Water bodies and *Tilapia Mozambica* Fish Organs of Bhima River (MS)

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ABSTRACT

The present study was designed to assess the physico-chemical parameters and heavy metal bioaccumulation (Mn, Fe, Zn, Cu, Cd and Pb) in water and *Tilpia mozambica* fish tissues. Analyzed parameters were compared with water quality standards to demonstrate their ability to support fish species in selected site. Chemical characteristics as pH, total alkalinity and total hardness strongly influenced the bioaccumulation of metals in water. Higher concentration of Cd, Pb found to be in gills than other tissues except Mn. The concentration of all metals in water sample was found below the notified toxic limit except Cd. The bioaccumulation of heavy metals in fish tissues causes detrimental effects on fish.

Keywords: Heavy metals, Physico-chemical parameters, Pollution, *Tilapia-mozambica*

INTRODUCTION

Water is one the most precious gift of nature. No life without water could survive on earth. Earth is the planet having about 70% of water. Lakes and rivers are very important part of our natural heritage. They have widely been utilized by mankind over the centuries to the extent that very few, if not many are now in a natural condition[1]. The maintenance of healthy aquatic ecosystem is dependent on the physico-chemical properties and biological diversity[2-3]. These physico-chemical conditions have a very significant impact on the living environment of fish and therefore on fish farming activity. Indeed, water quality is one of the main factors, which influence the quality of fish, its growth and production[4]. Heavy metals may enter aquatic system from different natural and anthropogenic sources including industrial or domestic wastewater, applications of pesticides and inorganic fertilizers, leaching from landfills and atmospheric deposition[5].These heavy metals could be deposited in aquatic organisms as a result of bioaccumulation via the food chain process and become toxic when accumulation reaches a high level[6]. Metal accumulation in fish tissues poses a direct threat for human being[7].

The accumulation of heavy metals in fish is depending on metal concentration, period of exposure, metal uptake and environmental factors such as water temperature, pH, electrical conductivity, alkalinity, hardness, dissolved oxygen[8]. Fish is an inexpensive source of protein and its exploitation is an important commercial activity in many parts of world[9]. Bhima river is of immense significance in terms of ecological services and fisheries resources. It is believed to provide feeding and spawning grounds for *Tilapia mozambica* and other fish species. *Tilapia mozambica* is a very

popular as it is flourishing in healthy way and its productivity is higher than other species. *Tilapia mozambica* is a good bioaccumulator of heavy metals and it can be used as indicator for environmental pollution monitoring.

In this study, the physico-chemical parameters like pH, temperature, electrical conductivity(EC), total dissolved solids(TDS), dissolved oxygen(DO), biological oxygen demand(BOD), total alkalinity(TA), total hardness(TH), Ca^{2+}, Mg^{2+} and some metal concentrations such as Mn, Fe, Zn, Cu, Cd and Pb of water sample and *Tilapia mozambica* were analyzed. The main objective of this study was to determine the physico-chemical parameters and metal concentrations of the Bhima river water for their ability to support aquatic species, especially *Tilapia mozambica* as it is primary source of income and livelihood for the local fisherman of the study area.

MATERIALS AND METHODS:

STUDY AREA:

Bhima river is a major river in western india and south india. Bhima river is situated at Northern latitude 17° 57.6408′ and Eastern longitude 75° 1.5963′. The Bhima river has become a place for fish and other aquatic organisms growth. In fact, this water body has attracted the attention of local fisherman, as *Tilapia mozambica* is a very popular fish of the study area. Establishment of various industries near the study area, also increased domestic activities, urbanization and agricultural growth in and around has led to significant impact on quality of water and the health of the aquatic ecosystem and in turn to human's health.

SAMPLING STRATEGY:

Water Sampling:

Water samples at depth of half meter from the water surface at sampling station (near industrial zone) were collected in a sterilized 1 liter polythene bottles. The collected samples were brought to laboratory immediately for further analysis.

Fish Sampling and Treatment:

Tilapia mozmabica with length of 13-14 cm and total weight of 40-60 g were collected from flowing river by wire of net having 2.5 nm diameter. The fish samples were collected in 2 liter polythene bottles and taken to the laboratory for further treatment. The collected *Tilapia mozambica* species after washing were dissected with sterile scissors to remove gills, muscles and liver. The fish samples were dried separately in an oven at 80 ^{o}C for 3 days. Then dried fish samples were pulverized using mortar and pestle into a fine powder. The homogenized powder samples were digested according to the procedures[10]. 2 gm of sample were digested using 1:5:1 mixture of 70 % perchloric acid, conc. nitric acid and conc. sulphuric acid at 80 ^{o}Cin a furnace for 2 hrs. Digested sample was made up to 20 ml with distilled water and samples were analyzed further for physico-chemical parameters and heavy metals.

RESULTS AND DISCUSSION

Table 1: Physico-chemical parameters of water sample

Sr. No.	Parameters	Range
1	Temperature	27.5 ^{o}C
2	pH	7.8
3	Electrical conductivity	96.9
4	Total dissolved solids	950.4
5	Dissolved oxygen	5.80
6	Biological oxygen demand	6.3
7	Total alkalinity	315.4
8	Total hardness	241.5
9	Ca^{2+}	219.6
10	Mg^{2+}	72.3

EC in µs/cm, All other units in mg/l

Table 2: Comparative heavy metals accumulated in water and *Tilapia mozambica* tissues

Heavy metals	Concentrations			
	Water	Gills	Liver	Muscle
Mn	0.284	23.45	0.82	12.6
Fe	2.254	1489.32	698.34	63.9
Zn	0.097	778.82	452.16	38.4
Cu	0.018	50.96	89.02	12.3
Cd	0.060	1.34	0.51	0.934
Pb	0.082	4.58	3.24	1.68

Heavy metal concentration in (µg/g) and water metal concentration in mg/l

The Physico-chemical parameters of water are disturbing due to industrial and anthropogenic activities. The degree of heat is measured in the form of temperature. Temperature influences the absorption, detoxification and excretion rates of pollutants, varying the bioconcentration[11]. The temperature recorded was found 27.5 ^{o}C. The pH of the water sample measured at situ was seen 7.8 showing alkalinity. It is well known that pH of water does not cause any severe health hazards. Electrical measurements estimates dissolved salts in water and its value varies with season[12]. Electrical conductivity (EC) is an indirect measure of the ions concentration. Highest electrical conductivity 96.9 µs/cm was recorded, such increase may be due to high evaporation rate. Total dissolved solids (TDS) are an important parameter for drinking water and water to be used for other purposes. Here in this, the concentration of TDS was in the range of 950.4 mg/l.

Dissolved oxygen is an important parameter in assessing the water quality. Lower DO value 5.80 mg/l was recorded. This decrease may be due to discharge of industrial effluents into the river, also discharge of municipal wastewater and other wastes[13]. Biological oxygen demand (BOD) is found to be more sensitive for organic pollution. BOD of water sample collected showed highest BOD i.e. 6.3 mg /l. Total alkalinity is the water's ability to resist change in pH. Alkalinity of water is taken as an indication of carbonate, bicarbonate and hydroxide in water. The total alkalinity measured was seen to be 315.4 mg/l. Total hardness(TH) is an important factor for domestic as well as industrial purposes. The concentration of total hardness was found beyond the permissible limit i.e. 241.5 mg/l. Higher concentration is due to dissolved sulphates, bicarbonates, chlorides[14].

Calcium (Ca^{2+}) is essential for healthy growth of bones playing important role in biological system. Calcium also contributes to the total hardness of water. High calcium value 218.4 mg/ l was recorded. Magnesium is also a beneficial metal but is toxic at higher concentration. The magnesium value was found to be 186.3 mg /l.

The concentration of heavy metals in water of studied region remained well below the guidelines proposed by WHO[15]. The concentration of the metals exhibited a wide range of variation between tissues as gills (G), liver (L) and muscles (M). The highest concentrations of all studied metals were recorded in the liver (except Mn). Manganese showed highest concentration 23.45 µg/g in the gills[16] and lowest concentration 12.6 µg/g in the muscle of fish.

The highest Fe concentration was recorded in the gills of fish (1489.32 µg/g) and lowest in the muscles i.e. 63.9µg/g. The increase of iron accumulation in fish gills and liver may be due to increase of dissolved iron, thereby increasing metal uptake by different organs[17].The highest level 452.16µg/g of zinc was recorded in the liver and lowest 38.4 µg/g in the muscle of *Tilapia mozambica.*

Copper exhibited the highest concentration 89.23 µg/g in liver than other tissues. This increase may be due to industrial and sewage waste[13]. The lower concentration of Cu in gills than liver was possibly due to lower binding affinity of Cu on the gills surface. The highest cadmium accumulated in gills as 1.34 µg/g. Higher concentration of lead can occur in aquatic organisms close to anthropogenic sources, industrial discharge, agricultural waste[18]. Here Pb concentration was found in gills 4.58 µg/g compared to liver and muscles.

CONCLUSION

In this study, assessment of Physico-chemical parameters and heavy metal pollution load in Bhima river water and *Tilapia mozambica* were carried out by employing the water quality index. The findings revealed somewhat higher level of pollution loaded with pH, TDS, total alkalinity and total hardness. Determination of heavy metal contamination in *Tilapia mozambica* showed higher concentration of Cd, Pb, Fe because of the close proximity of the sampling site to an industrial zone as well as agricultural runoff. Bioaccumulations of heavy metals are differing in the different tissues of *Tilapia mozambica*. The implications of the current findings is that domestic recreational and agricultural consumption of Bhima river at the studied point without prior treatment might negatively disturb the health of man, aquatic ecosystem and plants in the vicinity of the polluted water. This suggests Bhima river water at selected site was grossly unfit for domestic and recreational uses also the commercially available fish species may not be total safe for consumption.

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