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METAL IONS TOXICITY IN AQUATIC LIFE AT SONE RIVER

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ABSTRACT

The tremendous increase in the use of heavy metals over the past few decades has inevitably resulted in an increased flux of metallic substances in the aquatic Environment. The metals are of special concern because of their diversified effect and the range of concentration stimulated toxic ill effect to the aquatic life forms. Industrial wastes constitute the major source of metal pollution in natural water. Aquatic systems are exposed to a number of pollutants that are mainly released from effluents discharged from industries, sewage treatment plants and drainage from urban and agricultural areas. These pollutants cause serious damage to aquatic life.

Keywords: Industrial wastes, damage, aquatic life.

INTRODUCTION

In recent years the accumulation of metals in the aquatic ecosystem has become a problem of great concern throughout the world. These metals may accumulate to a very high toxic levels and cause sever impact on the aquatic organisms without any visible sign. Increase in population, urbanization, industrialization and agriculture practices have further aggravated the situation [1]. Soils and waters in many parts of the world are polluted by all kinds of chemicals and toxic heavy metals like cadmium, lead, chromium and mercury. In several countries effluents are often disposed directly into the surface waters .The introduction of metallic pollutants into a water system, whether it is natural (erosion) or artificial (anthropogenic), can occur in dissolved and particulate form. Depending on physico-chemical conditions, the pollutants in dissolved form can latter precipitate.

Heavy metals are widely used in automobiles, mining industries, pesticides, house-hold appliances, dental amalgams, paints, photographic papers, photo chemicals etc., pollution of surface water system through anthropogenic activities is the major environmental problem faced all around the globe [2]. Distribution of heavy metals in water, sediments, plants and fish, vegetables play a key role in detecting sources of heavy metal pollution in aquatic ecosystem .Trace metal contaminations are important due to their potential toxicity for the environment and human beings . Some of the metals like Cu, Fe, Mn, Ni and Zn are essential as micronutrients for the life processes in animals and plants while many other metals such as Cd, Cr, Pb and Co have no known physiological activities [3].

Bioaccumulation of heavy metals

Unlike many other pollutants in the environment, heavy metals are non biodegradable Remediation processes for heavy metal-polluted ecosystems are difficult, and expensive. Heavy metals can also be accumulated by some organisms either directly (e.g., in the case of macro algae) or through the food chain, eventually posing a serious health risk to inhabitants of an ecosystem, including humans., The bioaccumulation of toxicants, such as heavy metals, by living organisms is often a good integrative indicator of expo-sure, and has been extensively used to assess contamination levels of heavy metals in polluted ecosystems [4]. Macro algae are major primary producers in the marine environment and play an important role in food chains. Since marine pollution is most serious in coastal waters adjacent to

major pollutant sources, macro algae from marine environment are particularly suitable for pollution studies. Additionally, they have the ability to accumulate high levels of various metals in their cell walls Macro algae, especially from the Phaeophyceae, have, besides negatively charged polysaccharides, special compartments (physodes) that enhance their ability to accumulate high concentrations of heavy metals [5]. The accumulation of heavy metals by macro algae can take place either passively or actively. Macro algae have been used in studying the contamination status of coastal ecosystems, due to their ability to accumulate and tolerate high metal concentrations. Unlike several other bio indicators of heavy metal contamination (such as filter-feeding animals), macro-algae accumulate only metal ions that are dissolved in the seawater [6].

Toxicity of heavy metals

Several studies have reported on the toxic effects of heavy metals on various species of macro algae. Most studies of macro algae have been done in temperate regions, while information regarding tropical environments, especially the Western Indian Ocean is scarce. As well, it has been found that different species may respond differently when exposed to different heavy metals. It has previously been reported that even the same species growing in different areas subject to different environmental parameters may respond differently to heavy metal contamination [7]. Furthermore, several other factors, such as concentration of dissolved metal, pH, salinity, temperature and nutrients, are known to influence the toxicity of certain metals to macro algae. Thus, the mechanism of heavy metal toxicity to plants is yet well understood. Research into how various species from different areas respond to various heavy metals at different levels could help improve our understanding of the action of heavy metals on [8].

The toxicity of heavy metals in macro algae has been reported to follow the general order of Zn < Pb < Ag < Cd < Cu < Hg, which may vary depending on experimental conditions and macro algal species. Heavy metals are among the major environmental hazards due to their affinity for metal sensitive groups, such as thiol groups. Heavy metals block functional groups of proteins, displace and/or substitute essential metals, induce conformational changes, denature enzymes and disrupt cells and organelle integrity [9]. Different heavy metals have been reported to affect macro algae by interacting with enzymes and inhibiting their normal functions Asscher Heavy metal toxicity is often linked to the formation of free reactive oxygen radicals causing the inhibition of macro algae development. Molecular oxygen's un reactive with organic molecules because it has two unpaired valence shell electrons in outer shell. However, when activated through reduction it forms reactive oxygen species (ROS) such as superoxide radical (O_2^-), singlet oxygen ($^1O_2$), hydrogen peroxide (H_2O_2), hydroxyl radical (OH^-) and finally water (H_2O). Reactive oxygen species are toxic because they have ability to interact rapidly with biological molecules (proteins, lipids, DNA) causing oxidative stress which can result into cell death via apoptosis or necrosis Oxidative stress occurs as a result of imbalance between the production of reactive oxygen and a biological system's ability to readily detoxify the reactive intermediates or easily repair the resulting damage.

Damage as a result of oxidative stress can occur in biological molecules such as DNA, proteins and lipids. Oxidative attack on proteins results in site-specific amino acid modifications, fragmentation of the peptide chain, aggregation of cross-linked reaction products, altered electrical charge and increased susceptibility to proteolysis. The oxidative degradation of protein is enhanced in the presence of metal cofactors that are capable of redox cycling, such as iron. In these cases, the metal binds to a divalent cat ion binding site on the protein. The metal then reacts with hydrogen peroxide in a Fenton reaction to form a hydroxyl radical that rapidly oxidize an amino acid residue at or near the cat ion binding site of the protein (Stadtman, 1986). Detoxifications of ROS are mainly by production of antioxidants such as enzymes (superoxide dismutase, catalase, peroxidase), thioredoxin superfamiliy, glutathione and vitamin E [10].

MATERIAL AND METHOD

The Study Area

Paper industry and alkali industry are most common industry Situated all over world. The orient paper mill at Amlai (M.P) is one of the biggest paper plant of our country. These industries are situated on the left bank of sone river and about 2.5 K.M north –east of Amlai station in south –eastern railway .

Sampling Station

11 sampling station were selected along the course of the river Sone from Chachai to Devlod. Which cover distance of about 216 KM.

Upstream station

(1) Chachai water tank.

Effluent mixing stations:

(2) Opm effluent before mixing the river.
(3) Opm effluent sone river mixing point.
(4) HJM effluent before mixing the river.
(5) Opm and HJM effluent mixing with sone river water.

Downstream stations:

(6) After 300 meter from effluent mixing point.
(7) Bhatura ghat.
(8) Turturia ghat.
(9) Jarwahi ghat.
(10) Diapiper.
(11) Devlod.

Chemical Parameter

(1) Carbonate ions:- Carbonate ions were analyzed by titrated method using phenol pthalium and methyl orange as indicator.

(2) Chloride ions:- Chloride ions were estimated titrimetrically using Mohr method .

(3) Sulphates ions:- Sulphates ions were estimated turbid metric method using double beam spectrophotometer at 420 nm.

(4) Biological oxygen demand:- BOD was determined in accordance with the method prescribed by stander methods .

(5) Carbone oxygen demand:- COD was determined by dichromate reflux method using stander potassium dichromate.

Heavy Metal Analysis

(1) Mercury:- Hg was analyzed with the help of Hg analyzer MA5800 E (E cell) .

Formula for calculation:-

= Known amount of solution × Optical density / Amount of dried matter taken.

(2) Lead:- Lead, Copper, Chromium and Zinc were analyzed with the help of atomic absorption spectro photometers.

Calculation

= Ug /gm heavy metals = CV/ W

C = mg /heavy metal in sample

V = Sample volume in ml

W = wt .of sample in gm

METHODLOGY

Physico- chemical analysis

Physical characteristics:

(1) Colour: Taste and odor were determined by usual observation.

(2) Temperature: Was measured with the help of a mercury bulb centigrade thermometer.

(3) P.H : PH values were determine by electronic method with a portable grip PH meter .

(4) Procedure: Metallic plate with central hook, good quality nylon rope and measuring tape. Now lower the plate with water till it reached the bottom. Turbidity meter was used for the determination of turbidity in water.

(5) Total solids (T.S): Sample evaporating dish of 100ml capacity were taken and after dying them completely their initial weights were noted

T.S (mg/1t) = A-B ×1000×1000/50

Where A= Final weight of the dish in gm. B = Initial weight of the dish in gm.

Total suspended solids (TSS): Total suspended solids were determined as the difference between the total solids (TS) and total dissolved solids and presented.

TSS (MG/L) = T.S- T.D.S

OBSERVATION

The fallowing observation had been recorded in Sone River and their 11 Sampling Station.

Table 1. Heavy Metals Concentration in River Water (mg/l) SUMMER 2013

S.No	Sampling Station	CU	ZN	Cr	Pb	Hg
1	Chachai water tank	-	-	-	-	-
2	Opm effluent	0.049	.09	0.69	0.04	-
3	Opm + sone river mixing point	0.041	0.06	0.047	0.034	-
4	Hjm effluent	0.019	0.001	0.02	ND	0.061
5	Opm + Hjm effluent mixing point	0.047	.05	0.50	.0.03	0.054
6	After 300 mtr	0.17	0.027	0.35	0.028	0.049
7	Bhatura ghat	0.010	0.019	0.33	0.025	0.043
8	Turturia ghat	0.009	0.012	0.032	0.023	0.039
9	Jarwhai ghat	0.008	0.003	0.19	0.017	0.030
10	Diapiper	0.002	0.001	0.04	0.001	0.017
11	Devlond	ND	ND	ND	ND	ND

Table 2. Heavy Metals Concentration in River Water (mg/l) MONSOON 2013

S.No	Sampling Station	CU	ZN	Cr	Pb	Hg
1	Chachai water tank	-	-	-	-	-
2	Opm effluent	0.067	0.093	0.74	0.039	-
3	Opm + sone river mixing point	0.062	0.081	0.057	0.037	-
4	Hjm effluent	0.01	ND	ND	ND	0.068
5	Opm + Hjm effluent mixing point	0.054	0.08	0.53	.0.032	0.061
6	After 300 mtr	0.032	0.071	0.39	0.03	0.053
7	Bhatura ghat	0.021	0.062	0.30	0.021	0.047
8	Turturia ghat	0.020	0.047	0.29	0.02	0.037
9	Jarwhai ghat	0.007	0.008	0.03	0.009	0.019
10	. Diapiper	ND	0.002	0.005	ND	0.013
11	Devlond	ND	ND	ND	ND	ND

Table 3. Heavy Metals Concentration in River Water (mg/l) WINTER 2013

S.No	Sampling Station	CU	ZN	Cr	Pb	Hg
1	Chachai water tank	-	-	-	-	-
2	Opm effluent	0.063	.083	0.670	0.037	-
3	Opm + sone river mixing point .	0.050	0.082	0.0450	0.035	-
4	Hjm effluent	0.019	ND	0.019	ND	0.058
5	Opm + Hjm effluent mixing point.	0.043	.067	0.479	.0.033	0.052
6	After 300 mtr.	0.027	0.062	0.300	0.027	0.047
7	Bhatura ghat	0.020	0.043	0.310	0.021	0.039
8	Turturia ghat .	0.015	0.040	0.270	0.019	0.032
9	Jarwhai ghat.	0.009	0.010	0.150	0.006	0.030
10	. Diapiper	0.003	0.005	0.070	ND	0.01
11	Devlond	ND	ND	ND	ND	ND

Table 4. Heavy Metals Concentration in River Water (mg/l) SUMMER 2014

S.No	Sampling Station	CU	ZN	Cr	Pb	Hg
1	Chachai water tank	-	-	-	-	-
2	Opm effluent	0.040	0.082	0.650	0.030	-
3	Opm + sone river mixing point .	0.030	0.060	0.400	0.028	-
4	Hjm effluent	0.020	.001	0.020	ND	0.057
5	Opm + Hjm effluent mixing point.	0.040	0.050	0.420	.0.028	0.051
6	After 300 mtr.	0.010	0.020	1.320	0.021	0.043
7	Bhatura ghat	0.008	0.010	0.300	0.020	0.037
8	Turturia ghat .	0.08	0.009	0.290	0.02	0.031
9	Jarwhai ghat	0.069	0.002	0.090	0.010	0.023
10	. Diapiper	0.001	0.002	0.030	ND	0.017
11	Devlond	ND	ND	ND	ND	ND

Table 5. Heavy Metals Concentration in River Water (mg/l) MONSOON -2014

S.No	Sampling Station	CU	ZN	Cr	Pb	Hg
1	Chachai water tank	-	-	-	-	-
2	Opm effluent	0.060	0.080	0.67	0.040	-
3	Opm + sone river mixing point .	0.047	0.070	0.420	0.037	-
4	Hjm effluent	0.020	ND	0.010	ND	0.069
5	Opm + Hjm effluent mixing point.	0.040	0.060	0.410	.0.032	0.060
6	After 300 mtr.	0.020	.070	0.290	0.028	0.051
7	Bhatura ghat	0.010	0.040	0.240	0.027	0.043
8	Turturia ghat .	0.009	0.030	0.200	0.025	0.031
9	Jarwhai ghat	0.007	0.009	0.010	0.0020	0.013
10	. Diapiper	0.002	0.001	0.007	ND	0.010
11	Devlond	ND	ND	ND	ND	ND

Table 6. Heavy Metals Concentration in River Water (mg/l) WINTER 2014

S.No	Sampling Station	CU	ZN	Cr	Pb	Hg
1	Chachai water tank	-	-	-	-	-
2	Opm effluent	0.040	0.090	0.049	0.038	-
3	Opm + sone river mixing point .	0.060	0.030	0.043	0.035	-
4	Hjm effluent	0.010	ND	ND	ND	0.052
5	Opm + Hjm effluent mixing point.	0.050	0.030	0.410	.0.031	0.047
6	After 300 mtr.	0.030	0.010	0.340	0.030	0.032
7	Bhatura ghat	0.020	0.060	0.230	0.025	0.033
8	Turturia ghat .	0.025	0.045	0.210	0.021	0.027
9	Jarwhai ghat	0.005	0.007	0.20	0.01	0.019
10	. Diapiper	ND	0.001	ND	ND	0.012
11	Devlond	ND	ND	ND	ND	ND

RESULTS

The water sampling done for measurement of the heavy metal ions toxicity in Sone river at different session in during period of two years from 2013 to 2014 .In the summer session both years cu concentration increase from 0.049 mg to 0.08 mg. Whereas the Zn concentration in summer at both years from .082 mg to 0.09 mg. In summer session Cr concentration at both years increases from 0.0650 mg to 0.0690 mg. Pb concentration in summer session at both years from 0.03mg to 0.04 mg. Hg concentration in summer session at both years decrease from 0.061 mg to 0.057 mg. In Monsoon session both years Cu concentration are decreases From 0.067 mg to 0.060 mg. Zn concentration decreases from 0.093 mg to 0.08 mg. Cr concentration decreases from 0.74 mg to 0.67 mg . Pb concentration increases up to from 0.039 mg to 0.040 mg. Hg concentration increases from 0.068 mg to 0.069 mg in Monsoon session at both years.

In winter session at both years Cu ions concentrations are from 0.069 mg to 0.040 mg. Zn concentration are increases from 0.083 mg to 0.093 mg. Cr concentration are decreases from 0.0670 mg to 0.049 mg. Pb concentration increases from 0.037 mg to 0.038 mg. Whereas Hg concentration decreases from 0.058 mg to 0.052 mg. This study shows that higher concentration in metal ions makes many diseases in living things at aquatic life.

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