ISSN 0976 – 3333

Available Online at www.ijpba.info

International Journal of Pharmaceutical & Biological Archives 2012; 3(1):112-116

ORIGINAL RESEARCH ARTICLE

Seasonal Variation of Heavy Metals Distribution and Sediments in Palar River in and Around Vaniyambadi Segment, Vellore District, Tamil Nadu, India

C. Prabhahar*[1], K .Saleshrani[2] and K. Tharmaraj[1]

[1]*Department of Zoology, Annamalai University, Annamalai Nagar - 608 002, Chidambaram, Tamil Nadu, India*
[2]*Department of Zoology, Manonmaniam Sundaranar University, Thirunelveli, Tamil Nadu, India*

Received 09 Nov 2011; Revised 12 Jan 2012; Accepted 18 Jan 2012

ABSTRACT

In the present investigation the levels of heavy metals in Palar River water at Vaniyambadi segment were analysed to assess the water quality. Likewise, heavy metals such as Cadmium (Cd), Chromium (Cr), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Nickel (Ni), Strontium (Sr) and Zinc (Zn) were analysed in surface water, sediment and sediment elutriate of Palar river at Vaniyambadi segment. The sample analysis was done by microwave assisted digestion and Atomic Absorption Spectrophotometer.

Keywords: Palar River, Vaniyambadi, Heavy metals and Atomic Absorption Spectrophotometer.

1. INTRODUCTION

Water pollution can be defined in several ways. Usually it means one or more substances have built up in water to such extent that they cause problems for animals and humans. Rivers, lakes and oceans can naturally clean up a certain amount of pollution by dispersing it harmlessly. Earth's water resources are oceans, rivers and lakes and these resources are called surface waters. The most obvious type of water pollution affects surface waters, as evidence from a spill from an oil tanker creates an oil slick that can affect a vast area of the ocean. A great deal of water is held in underground known as aquifers which cannot be seen, that resource is known as groundwater. Aquifers feed rivers and supply drinking water. Groundwater pollution is much less obvious than surface - water pollution, but is no less of a problem.

Heavy metals such as cadmium, arsenic and lead can cause severe problems in aquatic environments due to their persistence, toxicity and tendency to accumulate in tissues [1]. While these constituents have been extensively studied, their chemical reactions in the environment and their overall effects on aquatic life are much complex and are poorly understood. It is well known that the fate and transport of metals in the environment is governed by the metals interactions and reactions with water, sediments and aquatic organisms [2]. Borovec (2000)[3] demonstrated the importance of grain size distribution in relation to transport of copper, zinc, lead, silver and chromium. Since large portions of metal loadings are associated with the solid particles and thus transported *via* particulate matter in the aquatic environment, many workers have addressed the role of grain size and organic matter of sediments [4]. Furthermore, concentrations may rely on other sources such as loads in storm water run-off, remobilized metals that were bound on river sediments and even loadings from atmospheric deposition. The toxical impacts of heavy metals on the environment have been investigated. Toxicological evaluations often make use of aquatic bioassays in which the effect of a contaminant on an aquatic organism has been assessed.

2. METRIALS AND METHODS

Water samples were taken from the Palar River at Vaniyambadi segment using acid washed polypropylene containers of one litre capacity from a depth of 10 to 25 cm. The concentrations of Cadmium (Cd), Chromium (Cr), Cobalt (CO), Copper (Cu), Iron (Fe), lead (Pb), Manganese (Mn), Nickel (Ni), Strontium (Sr) and Zinc (Zn) were analysed. The water samples were filtered through millipore filtering unit. The filtered water samples were pre-concentrated with APDC-MIBK extraction procedure. Filtered water (1 litre) was divided into two 200 ml aliquots and the pH was

***Corresponding Author:** C.Prabhakar, **Email:** prabhaharc@yahoo.com

adjusted to 4 ± 0.1 by careful drop wise addition of 50% nitric acid. The metals were preconcentrated and separated from the bulk matrix by complexation with APDC (Ammonium pyrrolidane dithio carbomate) and extracted into MIBK (Methyl iso-butyl ketone). The organic layer containing the metal chelates was collected and back extracted with 50% nitric acid and diluted with deionized water to a minimum quantity of 25 ml. This solution was aspirated into a standard atomic absorption spectrophotometer (Perkin Elmer Model-373) for the determination of metal concentrations against blank [5].

3. RESULTS AND DISCUSSION

The levels of heavy metals recorded in Palar river water at Vaniyambadi segment are presented in (**Table 1**). The metals concentrations registered in the present study in Palar river water at Vaniyambadi segment showed a range of Cd 1.48 – 1.69 mg L^{-1}, Cr 3.20 – 3.98 mg L^{-1}, Co ND, Cu 1.62 – 1.76 mg L^{-1}, Fe 2.30 – 3.09 mg L^{-1}, Pb 1.40 – 1.60 mg L^{-1}, Mn 0.76 -0.93 mg L^{-1}, Ni 0.30 – 0.45 mg L^{-1}, Sr 0.85-0.96 mg L^{-1} and Zn 2.50-3.05 mg L^{-1}. Generally the values were exceeded the desirable limit of BIS and WHO standards. Heavy metals usually present in trace amounts in natural waters but many of them are toxic even at very low concentrations. Their concentration increase in water due to addition of industrial wastes and sewage/non-point source pollution. Some of them get biomagnified in higher trophic levels.

Exposure to toxic metals is often assessed by measurements in air, foods and waters and sometimes also in soil and other materials, i.e., environmental monitoring. Some problems may be overcome by employment of biological monitoring, i.e., the use of biomarkers for assessment of exposure to metals. The biomarkers take into account exposure from different sources, air, foods and water, soil, and through various routes like inhalation, gastrointestinal and skin. Recently, new possibilities for biological monitoring of elements have been developed. Thus, neutron activation and X-ray fluorescence (XRF) techniques may be used for assessment *in vivo* of contents of some elements in the kidney, liver and bone.

The significance of the heavy metals as well as their effects on the living animals are suggested below. It is well established that cadmium binds to the sulfydryl group of proteims. If this occurs on an enzyme, its function may be inhibited, which may result in toxic effects. Welding and soldering with materials containing cadmium may cause severe lung damage. In take of food or water containing very high amounts of cadmium may cause acute abdominal disorder. The proximal tubuli of kidney are mainly affected. Cadmium causes genotoxic effects in a variety of types of eukaryotic cells, including human. Cadmium and its compounds are carcinogenic in humans, as are cadmium compounds in animals.

Nickel is a ubiquitous metal. The concentration in the earth's crest in about 0.008%. It is mainly used for production of stainless steel and other nickel alloys. Important sources of nickel are combustion of coal and oil for heat and power generation, incineration of waste and sewage sludge, nickel mining and production, steel manufacture and electroplating [6] Critical organs for nickel exposure in humans are the respiratory system, nasal cavities, immune system and skin. Nickel poisoning can lead to headache, vertigo, nausea, vomiting, nephrotoxic effects, pneurnonia, pulmonary fibrosis, rhinitis, sinusitis, bronchial asthma, lung and nasal malignancies [6].

Manganese is an essential element for humans. It is a part of the enzyme mitochondrial superoxide dismutase in rats and is essential for many animal species for the formation of bone and connective tissues, and for the metabolism of carbohydrate and lipids. It is used for the production of steel, nonferrous alloys, dry cell batteries and chemical industry. Organic manganese compounds have been used as fungicides and as anti-knocking agent in gasoline. Lung and Brain are critical organs after manganese exposure. Exposure to manganese may cause irritation of the respiratory airways, dyspnea, and irreversible neurological disorder resembling both Parkinson's disease and dystonia. Chronic subcutaneous and intra peritoneal injections of mice with manganese chloride increased the frequency of lymphosarcomas and distal mammary adenocarcinomas and leukemias. Principal industrial users of chromium compounds are the metallurgical processors of ferrochromium and stainless steel. These compounds are also used for electroplating, pigment production and tanning. Hexavalent chromium compounds can cause irritation of mucus membranes and skin. Excessive chromium may cause lung cancer, tubular necrosis of the kidneys, and chronic bronchitis.

Cobalt is an essential metal for human and it is part of the enzyme cyanocobalamin, vitamin B_{12}. Critical organs after cobalt exposure include the skin, heart and the respiratory tract. Addition to cobalt chloride to beer has been used to improve the quality of the froth in Canada, the U.S. and Belgium, and the daily intake from food is about 5 to 45 µg/day. However, cobalt content not detected in Palar River water at Vaniyambadi segment.

Exposure to lead may cause demyelination, axonal degradation and presynaptic block. The peripheral nervous system damage causes paralysis and pain in the extremities. Lead inhibits the activity of the enzyme pyrimidine –5-nucleotidase in red cells. Heavy lead exposure is associated with reticulocytosis and occurrence of stippled erythrocytes in peripheral blood. Further the life span of circulating erythrocytes becomes shortened. Lead exposure may cause proximal tubular damage in the kidneys which is followed by aminoaciduria, glucosuria and hyperphosphaturia. After heavy exposure, interstitial nephritis, interstitial fibrosis, tubular atrophy, arteriosclerosis, decrease of renal plasma flow, followed by increase of blood urea nitrogen (BUN) resulting hyperuricemia. It also affects the gastrointestinal tract causing diarrhoea, epigastric pain, nausea and loss of appetite. The increased blood pressure effects may depend on kidney damage with secondary hypertension and no increase of cardio-vascular deaths among smelter workers. In lead poisoned males the spermatogenesis, sperm viability, motility and morphology are affected. Recent studies of women much less exposed to lead have given varying results like stillbirth, preterm delivery, reduction of gestational age and birth weight and sudden infant death. Alkyl lead poisoning is acute, causing irritability, headache, convulsion, delirium and coma [7].

Copper is an essential element in human. It can bind to proteins such as cytochrome oxidase and it is essential for many enzyme functions. Copper deficiency is associated with reduced haemoglobin formation, reduced elastin formation, teratogenesis and abnormal amino oxidase activity. Ingestion of copper has produced headache, dizziners, hemolytic anaemia, hemoglobinemia, hepatic and renal failure. Epidemiologic evidence, such as a high incidence of cancer among copper smiths, suggested a primary carcinogenic role for copper ions. Treatment of laboratory rodents with organo copper complexes caused an increase in the incidence of tumors in bone and lung.

The effects of copper on base incorporation by DNA polymerases and upon DNA synthesis rates have been studied. The potential for the copper salts cuprous chloride and cuprous acetate to act as putative mutagens and carcinogens has been shown by their ability to alter the fidelity of DNA synthesis *in vitro*. Overall RNA synthesis and the rate of initiation of RNA synthesis *in vivo* using *Escherichia coli*. RNA polymerase with calf thymus DNA and T_4 DNA templates were reduced by incubation with cuprous chloride. Copper binds with phosphate on nucleotides and nucleic acids and these complexes in the presence of hydrogen peroxide can produce point mutations [8].

Occupational exposure to iron compounds mainly oxides are common in mining, iron and steel foundry work, and in arc welding. Epidemiological studies have shown that an excess mortality from lung cancer has been observed in iron-ore miners from a number of countries such as those from the France, Minnesota, British Cumbria and Sweden. Repeated intramuscular, subcutaneous or parental administration of large doses of iron–carbohydrate complexes resulted in increased formation of metastisizing sarcomas in rats, mice, hamster and rabbits. Clinical studies have shown that iron promotes cancer cell growth. An excess dietary iron in female rates was more prominent than iron deficiency in the modification of the progress of mammary carcinogenesis [9].

Direct injection of zinc chloride into rooster testes caused the formation of testicular teratomas. Similarly, intratracheal instillation or intrapleural injection of zinc powder resulted in an increased incidence of testicular seminomas and localized lung reticulosarcomas. The ingestion of zinc salts has been shown to induce increased tumour formation and to increase the formation of tumours induced by other carcinogens in the early segments of the gastrointestinal tract. The presence of zinc chloride in drinking water has been correlated with an increased incidence of mammary carcinomas of rodents. Over a wide range of concentrations tested, both acute an chronic repeated injections of mice with zinc chloride induced chromosomal aberrations in bone marrow cells. When normal stimulated cultured human lymphocytes were pre-treated with various soluble zinc salts, there was an increase is the numerous of cells with chromosomal fragmentation, diploydy, dicentrism, and chromatid gaps and breaks. In higher animals,

IJPBA, Jan - Feb, 2012, Vol. 3, Issue, 1

zinc salts were capable of inducing mutagenic effects. Thus the number of dominant lethals and sex-linked mutations in the offspring of *Drosophila* were increased by treatment of adult flies with zinc chloride [10].

Problems arising out of water quality deterioration are as severe as those related to water availability. Rao and Mamatha (2004)[11] reported that nearly 70% of India's surface water sources were already contaminated. Apart from climate – induced changes which are long-term and very slow, direct anthropogenic modification of land cover such as agriculture, aforestation, mining, urbanization, industrialization and intervention on hydrological regimes like irrigation and damming has resulted in marked changes in water quality [12]. Even though some trace elements are very essential to human beings, at elevated level they could cause morphological abnormalities like reduction of growth and mutagenic effects [13]. Cadmium accumulation is associated with hypertension and osteomalacia. Lead poisoning is linked with permanent brain damage, behavioural disorders and impaired hearing.

Table 1: Heavy metals concentrations (Mg L^{-1}) in Palar river water at Vaniyambadi segment

Elements	Range values of water samples	Average concentration of water samples
Cadmium (Cd)	1.48 – 1.69	1.58
Chrmium (Cr)	3.20 – 3.28	3.59
Cobalt (Co)	*ND	-
Copper (Cu)	1.62 – 1.76	1.69
Iron (Fe)	2.30 – 3.09	2.70
Lead (Pb)	1.40 – 1.60	1.50
Manganese (Mn)	0.76 – 0.93	0.85
Nickel (Ni)	0.30 – 0.45	0.37
Strontium (Sr)	0.85 – 0.96	0.90
Zinc (Zn)	2.50 – 3.05	2.78

** ND = Not Detected.*

ACKNOWLEDGEMENT

The authors are deeply indebted to Professor and Head, Department of Zoology, Annamalai University, Annamalai Nagar, Tamil Nadu, India for their inspiring help, constant support and for providing adequate laboratory facilities in the department to carry out the research work.

REFERENCES

1. Siddmore, J.F. and I.C. Firth. 2008. Acute Sensitivity of Selected Australian Freshwater Animals to Copper and Zinc Australian Water Resources Council, Australian Government printing Service.
2. Radhakrishnaiah, K., Venkataramana, P., Suresh, A and Sivaramakrishna, B. 1991 Effects of lethal and sub-lethal concentrations of copper on glycolysis in liver and muscle of the freshwater teleost, *Labeo rohita*. *J. Environ. Biol*., 13 (1): 63-68.
3. Borovec. 2000. Acute zinc toxicity to rainbow trout (*Salmo gairdenri*): Confirmation of the hypothesis that death is related to tissue hypoxia. *Journal of Fisheries Research Board of Canada*, 29: 1463-1466.
4. Falk, H.L. 2004 Chemical carcinogens, mutagens and teratogens In: W.D.mckee (Ed). Environmental Problems in medicine. Charles C. Thomas Publishers, Springfield, Illinois.
5. James, R. 2010 Individual and combined effects of heavy metals on behaviour and respiratory responses of *Oreochromis mossambicus. Indian. J. Fish*., 37(2): 129-143.
6. Low-Jinde, L and A.J. Niml. 2004. Short-term and long-term effects of cadmium on glycogen reserve and liver size in rainbow trout (*Salmo gairdneri*). *Achieves of Environmental Contamination and Technology*, 13: 759-764.
7. Nielsen, F.H. 2011. Studies on the essentiality of nickel. In Newer Trace Elements in Nutrition. Edited by W.Mertz and W.E.cornatzer, marcel Dekker Inc. New York pp. 215-253.
8. Pederson, E., Anderson, A and G. Hogeveit. 2008. Second study of the incidence and mortality of cancer of respiratory organs among workers at a nickel refinery. *Annals of Clinical and Laboratory Science*, 8: 503.
9. Sesha Srinivas,V. and M.Balaparameswara Rao.1999. Chromium induced Histological alterations in the gill of the fresh water teleost fish, Labeo rohita (Hamilton). *Indian. J. Comp. Ani Phy.*, 17(1): 31-33.
10. Sures, B., Dezfuli, B.S., and H.F. Krug. 2003. The intestinal parasite

Pomphorhynchces *acanthocephala* laevis interfers with the uptake and accumulation of lead in its fish host chub *Leucicus cephalus*. *Inter. J. Parasitology*, 33 (14): 1617-1622.

11. Rao, S.R. and B.R. Mamtha. 2004. Changes in O_2 consumption of a slluroid fish *Mystus vittatus* put to different concentrations of some heavy metals salts. *Indian Journal of Experimental Biology*, 17: 274.
12. Bash. M. 2002. Studies on the effect of lead Nitrate on the histology of liver and kidney and glycogen levels in liver and muscle of *Clarias gariepinus*, M. Phil. Dissertation, Madras University.
13. Zhao- Yuan Feng, Lu Jing Cai, Wu-Ychun, Song-Xiao Yang, Wang- Fan, Lia-Change Fa, Xing – Dianlou and Liu-Jing. 2004. Effects of total organic carbon in the seawater on the accumulation of copper, lead and cadmium in the issues of paralichthys olivaceus. Transactions, Chinese, Society. *Agri. Engi*., 20 (3): 234-238.