ORIENTAL JOURNAL OF CHEMISTRY
An International Open Free Access, Peer Reviewed Research Journal
www.orientjchem.org

Est. 1984

ISSN: 0970-020 X
CODEN: OJCHEG
2012, Vol. 28, No. (4):
Pg. 1913-1918

Levels, Spatial Distribution and Possible Sources of Heavy Metal Contamination of Suburban Soil in Jhansi

RAVI KANT KANNAUJIA* and SURJEET SINGH

Department of Chemistry , Bundelkhand University Jhansi - 284 128, India.
*Corresponding author E-mail: ravikkannaujia@gmail.com

(Received: August 25, 2012; Accepted: November 06, 2012)

ABSTRACT

Heavy metal pollution has become a serious health concern in recent years, because of industrial and agricultural development. Heavy metals of industrial bio-waste contaminate drinking water, food and air. The toxic heavy metals of great concern are Cd, Pb and Hg which are usually associated with harmful effects in men and animals. It is recognized that heavy metals may exercise a definite influence on the control of biological functions, affecting hormone system and growth of different body tissues. Many heavy metals accumulate in one or more of the body organs with differing half-lives. The Heavy Metal Pollution Index (HPI) of ground water was found to be far below the index limit of 100 points indicating that the ground water was not polluted with heavy metals in spite of the prolific growth of mining and allied industrial activities near the town. India revealed that Cd concentration varied from 1.0 to 9.1 ppm, Cu varied from 8.0 to 10.2 ppm and Pb content ranged from 0.1 to 10.4 ppm. In many district of Uttar Pradesh, India, most of the water bodies are being used for the cultivation of edible aquatic plants. It was found to be contaminated with a variety of toxic metals like Fe, Cu, Cr, Mn and Pb. Soils irrigated with the effluents had higher contents of micronutrients and heavy metals as compared to the corresponding well irrigated soils. water, soil, grass and mineral salt samples to investigate the sources of toxicity in animals. In this paper discussed the metal Pb, Cd, Zn, Ni, Cu, Fe and Mn are in different concentration in all the study Jhansi sites.

Key words: AAS, Physico Chemical, Micronutrients, pH

INTRODUCTION

Pesticides, heavy metals and other agro-chemicals are some of the major causes of environmental toxicity in farm animals. Various anthropogenic activities such as burning of fossil fuel, mining and metallurgy, industries and transport sectors redistribute toxic heavy metals into the environment, which persist for a considerably longer period and are translocated to different components in environment affecting the biota[1-3]. Number of environmental cum medical surveys mainly involving human population in industrial, mining and urban areas have documented occurrence of toxicities due to effluents.

These toxicants are accumulated in the vital organs including liver and kidney and exert adverse effects on domestic and wild populations[4]. The effluents from livestock systems can affect the micro and macro environment, viz., water, atmosphere and food chain. Heavy metal toxicity is one of the major current environment problems and is potentially dangerous because of bio-accumulation through the food chain and this can cause hazardous effects on livestock and human health[5-8]. Heavy metals of industrial bio-waste contaminate drinking water, food and air. The toxic heavy metals of great concern are Cd, Pb and Hg which are usually associated with harmful effects in men and animals. It is recognized that heavy metals may exercise a definite influence on the control of biological functions, affecting hormone system and growth of different body tissues[9]. Many heavy metals accumulate in one or more of the body organs with differing half-lives. The non-essential heavy metals have, directly or indirectly, an adverse effect on biological activities. The presence of these metals in water degrades their quality, which eventually affects human health. Even the essential metals at higher concentration are toxic. The livestock systems are prone togeneral problems of pollution emanating from industrial activity The concentrations of Cu, Pb and Cd seasonally varied from 0.025 to 0.136, 0.205 to 0.598 and 0.0045 to 0.013 ppm, respectively.. The results indicated biologically significant contamination of water by heavy metals. Various sources contributed to the levels of heavy metals in the rivulet and harbor water, the major part came from industrial outfalls. Analyzing water used for irrigating fodder fields near a refinery factory, the Pb, Cd, Cu and Zn concentration from polluted areas was significantly higher than that of unpolluted controls[10]. evaluated the concentration of heavy metals like Cd, Pb, Cr, Cu and Zn in sea water collected from Istanbul[9]. The concentration ranges of Cr, Cd, Pb, Cu and Zn in sea water were 0.89-3.93, 0.32- 2.00, 1.29- 4.41, 0.60- 35.2 and 0.13-1.38 ppm, respectively. In China, Ping (2005) measured the concentration of heavy metals in water in the vicinity of the Baiyin mining area and found that the waste gases and waste water produced by melting metals in factories caused Pb, Cd, Cu and Zn pollution in the surrounding environment. the status of pollutants in soil in industrial area in Bangalore. The average soil pH was acidic (6.54 ppm) in industrial areas as compared to normal areas. The Pb (35.30 ppm), Cu (95.30 ppm), Zn (69.0) and Fe levels in soil of industrial areas was much higher than those ofnon-industrial areas. the soils under sewer water irrigation had higher concentrations of Zn, Cu, Pb and Cd when compared to fields irrigated by underground water[12]. They found higher levels of heavy metals in the area which was situated in the close proximity of the effluent discharge point. the heavy metal concentration in soil in the vicinity of industries around Coimbatore city in Tamil Nadu, India. The concentration of Cd in all the industrial areas was found above the normal level. Pb was found above maximum tolerable concentration in all sites except in the textile industrial area. high level of heavy metal concentrations in soil. Pb, Cd, Cu and Hg were 1360, 29.7, 817 and 40.8 ppm of soil dry matter, respectively[11]. the fodder samples in a polluted area and recorded the mean Pb concentration in forages as 706 ppm and the mean Cu, Pb, Cd concentration in forages as 1.116, 46, 1.075 ppm, respectively[14]. The fodder fed to animals in industrial areas of Punjab, India contained Pb concentration of 102 to 382 mg kg-1[15]. The Pb (2.40-145 ppm), Cd (0.50-10 ppm) and Cu (43- 251 ppm), Zn (19-50 ppm) and Iron (338-11600 ppm) content in the vegetation in an industrial area was found higher as compared to normal areas.

Plants grown on sewer water irrigation had higher concentration of Zn, Cu, Cd, Cr and Ni as compared to fields irrigated by underground water in Aligarh district of Uttar Pradesh, India . The concentration of Cr, Cu, Zn, Fe and Mn in the green roughage fed to Black Bengal goats had mean values of 0.80±0.01, 49.13, 36.89,353.71 and 96.58 ppm, respectively[17]. The mean values of micronutrients were Cu, Zn, Fe and Mn; 15.99, 48.4, 379.60,47.16 mg kg-1 and that of heavy metals were Cr, Ni, Pb, Cd; 134.8, 202.9, 64.02, 15.92 mg kg-1 , respectively. the biomonitoring of pollution in livestock production systems in industrialized area of Palakkad, Kerala, India. Heavy metals (Pb and Cd) in the blood of cows and buffaloes were studied in different parts of India. The Pb content in erythrocytes varied from 23.4 to 42.9 ppm. Normal blood Pb level in ruminants is 5 to 22.5 flg/100 mL. The blood concentration of Pb, Cu, Co and Zn were 1.06 ppm, 0.82 ppm, 0.51 ppm and 4.67 ppm, respectively in 28 days of exposure to Pb. Increase in blood Pb concentration in lead-exposed calves was associated with a decrease in blood Cu and increase in concentration[18].

MATERIAL AND METHODS

The sampling sits in four suburban areas of Jhansi, Baruasager, Shivajinager, Parichha, BHEL were illustrated in table-2, soil sample (0-10cm soil layer) were collected with stainless steel scoops and then stored in polythene bags. Samples were placed in dark and transported to the laboratory as soon as possible . soil samples were air dried ground and sived through a 2 mesh sieve. All samples stored in room temperature before analysis . in all the sites soil samples were analysed for various physic-chemical characteristics including trace metals by following standard method for trace metals, thee samples were digested with concentrated HNO3 and perchloric acid. The digested samples, then analysed using atomic absorption spectrophotometer .the metal Pb, Cd, Zn, Ni, Cu, Fe and Mn are reported in different concentration in all the study sites.

Atomic absorption spectrophotometer (AAS)

AAS is was used for metals analysis in the present study Heavy metals and as were determined with a analyst 100AAS . Heavy metals were determined in triplicate in a sample and the result were averaged . all chemical used were of analytical grade unless otherwise specified. DDW was used throughout the experiment. Prior to analysis all the nitric acid digestion. Spectroscopy is the measurement and interpretation of electromagnetic radiation absorbed, scattered or emitted by atoms, molecules or other chemical species. The electromagnetic radiation absorbed by atoms is studied in atomic absorption spectroscopy. This absorbance is associate with change in the energy states of interaction chemical species, since each species has characteristics energy states. In atomic absorption sperotrocopy, the flam that contains the free atoms become a sample cell. The free atoms absorb incident radiation focused on the cell from source external to the flam and reminde is transmitted to a detector where it is changed into an electrical single and displayed, usually after amplification, on a meter chart recorder or some other or some type of read-out device.

Flame atomic absorption spectrometry (FAAS) is a sample, high- speed and precise technique for the determination of metallic element. Unfortunately, this outstanding technique has lost its dominant position in modern inorganic analytical chemistry , especially where the high detection power is to be asked.

A well known reason for this are the moderate detection limits achievable by this technique. The sample solution is introduced as an aerosol into the flame and atomized,

A light beam from the source lamp (hollow cathode lamp, HCL) composed of that element (intense electromagnetic radiation with a wavelength exactly the same as that is absorbed maximum by the atoms) is directed through the flame, into a monochromatic and into a detector that measures the amount of the light absorbed by the atomized element in the flame . because each metal has its own characteristics absorption wavelength, the amount of energy at the characteristics wavelength absorbed in the flame is proportional to the concentration of the element in the sample over a limited concentration range.

Preliminary Digestion of Sample Containing Heavy Metals

5 ml conc. HNO3 was added to a beaker containing 50-100 ml sample and evaporated on a hot plate and the volume was reduced to about 50-20 ml. Heating and adding conc. HNO3 continued until to 100ml and mixed thoroughly. This was used for metal determination.

Principle

AAS measures the decrease in light from a source (hollow cathode lamp, HCL) when it passes through a vapour layer of the atoms of an analyte element. The hollow cathode lamp produces intense electromagnetic radiation with a wavelength exactly the same as that absorbed by the atoms, leading to high sensitivity.

Construction

It consists of a light source emitting the line spectrum of the element (hollow cathode lamp) , a device for vaporizing the sample (usually a flame), a means of isolation an absorption line (monochromatic) and a photoelectric detector with its associated electronic amplifying equipment.

Operating procedure

Hollow cathode lamp (HCL)for the desired element is installed in the instrument and wavelength dial is set according to the table and also slit width is set according to the manual. Instrument is turned on for about 20 min to warm up. Air flow rate and cuuent is adjusted according to the manual. Standard solution is aspirated to obtain maximum sensitivity for the element by adjusting nebulizer. Absorbance of this standard is recorded. Subsequent determination are made to check the consistency of the instrument and finally the flame was extinguished by Turing off first acetylene flame and then air.

Lamps

Separated lamp (HCL) is used for each element since multielement hollow cathode lamps generally provide lower sensitivity.

Pressure reducine valves

A vent is placed about 15-30cm above the burner to remove the fumes and vapors from the flam.

RESULT AND DISCUSSION

The physio chemical analysis of soil of suburans area of Jhansi at different sites are given in table 1 the pH of soil samples in baruasagar , shivaji nagar , parichha & BHEL area recorded in between 7.35-7.69. by contrast in the parichha area the pH of soil is 8.26. The pH of soil plays a vital role in regulating many physico chemistry reactions in the soil. Soil pH is generally correlated with the

Table 1: Physico Chemical Characterisitics of soil in Jhansi (mg/gm)

Parameter	Baruasagar	Shivaji nagar	Parichha	BHEL
pH	7.65 ± 0.278	7.69 ± 0.203	8.26 ± 0.397	7.35 ± 0.192
Conductivity in (mhos/cm)	0.23 ± 0.021	0.45± 0.79	0.35± 0.055	0.39± 0.50
Organic carbon %	0.133± 0.021	0.106 ±0.009	0.107± 0.021	0.078±0.88
Alkalinity	1.10 ± 0.014	0.14± 0.014	0.107 ± 0.022	0.13 ± 0.21
Chloride	0.03 ± 0.002	0.034 ± 0.003	0.037 ± 0.007	0.3 ± 0.004
Nitrates	0.293 ± 0.374	0.061 ± 0.027	0.76 ± 0.012	0.085 ± 0.065
Phosphates	3.340 ± 1.118	2.772 ± 0.514	0.513 ± 0.038	0.556 ± 0.081
Calcium	2.786 ± 0.568	8.097 ± 2.326	4.378 ± 0.862	2.352 ± 0.403
Magnesium	1.107 ± 0.857	2.53 ± 1.061	2.53 ± 1.061	0753 ± 0.182

Table 2: Physico Chemical Characterisitics of soil in Jhansi (mg/gm)

Parameter	Baruasagar	Shivaji nagar	Parichha	BHEL
pH	7.65 ± 0.278	7.69 ± 0.203	8.26 ± 0.397	7.35 ± 0.192
Conductivity in (mhos/cm)	0.23 ± 0.021	0.45± 0.79	0.35± 0.055	0.39± 0.50
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Table 3: Heavy metal concentration of soil in Jhansi (mg/gm.)

Element	Baruasagar		Shivaji nagar		Parichha		BHEL	
	Min .	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Lead (Pb)	0.9	1.4	47.0	56.1	ND	9.6	46.0	57.1
Calcium (Cu)	ND	1.1	ND	7.1	ND	5.5	0.17	4.1
Zinc (Zn)	2.7	3.6	50	64	60	80	56	69.0
Nickel (Ni)	36	56.7	65	250	30	66	71	23.0
Copper (Cu)	2.7	4.8	28	31	9.3	10	31	39.0
Manganese (Mn)	481	761	496	611	502	641	534	671
Iron (Fe)	0.38	0.41	0.4	0.44	0.41	0.53	0.47	0.57

ND = Not Detectable

amount of Ca, Mg soluble Fe, P and the microbial activity the soil at parichha area reported.

High amounts of Ca & P. this may be due to the alkaline reaction of the compounds that results in their greater availability and in term increase pH. The connectivity of the soil range between 0.23 to 0.45 m/mhos. In shiva ji nagar , parichha and BHEL areas reported high conductivity , compared with Baruasager area 0.23 m/mhas. It may due to the greater availability of can Mg which might have contributed to the increase in the electrical conductivity as it is well known the Ec of the soil , generally increases with the increased concentration of the dissolved salts. The organic carbon in the soil sample range between 0.78 to 0.133.the highest for Baruasagar area and lowest among 4 soil sample reported in BHEL area. Nitrates and phosphates are present in appreciable with shivajinagar and BHEL area. This may be due to the use of synthetic and organic fertilizer in Baruasagar area.

Spatial variations of metals with relatively higher concentration in soil, metals were illustrated in table-2. Trace metals can enter the soil by a number of pathway and their behavior and fates in soil, differ according to their sources and species. The value of iron in shivajinagar, parichha and BHEL areas, present in high concentration from 0.4 to 0.53 mg/g compared with Baruasagar.the shivajinager and BHEL soils recorded with Pb levels 46-56 mg/g. whereas parichha and Baruasagar areas low value 0.9-9.6 mg/g this may be concentration of zinc nickel, copper and manganese are reported high in shivajinagar , parichha BHEL areas compared to Baruasagar area .the important agricultural source of heavy metals in soil include commercial fertilizer ,chemicals, sewage sludge, urban soil wastes etc. the results of the present study also reposted higher concentration of trace metals in cultivating mainly vegetable crops in Baruasagar soils.

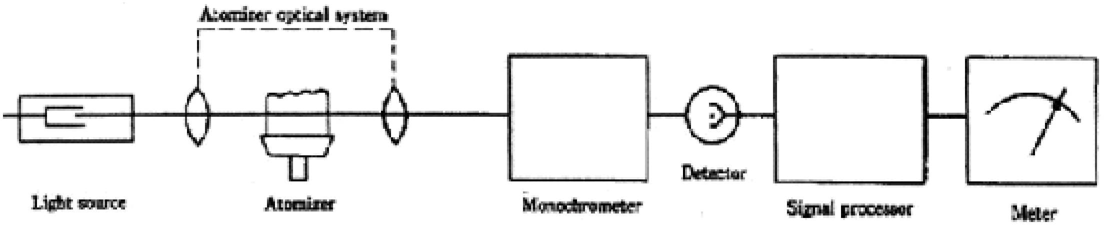

Fig. 1: Schematic flow diagram to depict the working principle of atomic absorption spectrophotometer

CONCLUSION

Although some metals in soil are necessary as a plant micronutrients Zn, Mn, Cu, Fe, Co presence of other trace metal Pb, Cd, Ni in higher levels may lead bioavailability to plant and quaintly of agriculture product and enter the food chain or reach down to ground water resources , thus causing in both cases health hazards to humans and animals. So there in need to minimize heavy metals pollution in soil.

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