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Research Article

ANALYSIS OF HEAVY METALS IN POTABLE WATER SAMPLES OF SATELLITE CITY OF GURGOAN, (HARYANA) INDIA

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ABSTRACT
Water pollution is one of the most serious problems confronting the modern human society, especially in urban areas as they are highly influenced by urban characteristics, population set up and usage of resources. Cities are subjected to fast immigration and therefore experience great anthropogenic pressure. Gurgoan is one of the four major satellite cities of India and is a part of National Capital Region (NCR). It is heavily industrialized and prolonged discharge of industrial effluents, metal pollutants, domestic wastes, agricultural runoffs etc. has resulted in the pollution of underground as well as surface water sources. Pollution by heavy metals can arise from many sources but most commonly arises from the purification metals, e.g. smelting of Copper and preparation of nuclear fuels. Electroplating is the primary source of Chromium and Cadmium[1]. Hence, potable water samples collected from various areas of Gurgoan were assessed for the presence of heavy metals like Lead (Pb), Cadmium (Cd), Mercury (Hg) and Arsenic (As).

Key Words: *Potable Water, Heavy Metals, Satellite city and National Capital Region (NCR)*

INTRODUCTION
The term heavy metals refer to any metallic elements that have relatively high density and are toxic even at low concentration. Some examples of heavy metals are Beryllium (Be), Aluminium (Al), Iron (Fe), Cobolt (Co), Nickel (Ni) Copper (Cu), Silver (Ag), Mercury (Hg), Lead (Pb), Arsenic (As) etc. They are naturally present in the earth's crust and may enter into human body through drinking water, food and air. Some of them are dangerous to health or to the environment (e.g. Hg, Cd, As, Cr, Pb), some may cause corrosion (Pb, Zn), some may be harmful in other ways (e.g. as may pollute catalysts). Some of them are actually necessary for humans in small amounts (Co, Cu, Cr, Ni), while others can have negative effect our central nervous system and can be carcinogenic as well (Hg, As, Pb), some many have adverse effect on kidneys or liver (e.g. Cu, Cd, Pb, Hg) while others may affect bones and teeth (Malkoc 2010). The contamination of water is directly related to the degree of contamination of our environment (Skeat, 1696). Since, Gurgoan is heading towards becoming a world class city and is a hub of many national and international activities, the supply of safe drinking water is a prime concern. Water quality refers to physical chemical and biological characteristics of water. The most common standards used to asses' water quality are not only related to the safety of human health but to that of ecosystem as well (Funari and Ottavini, 1997). Analysis of potable water for the presence of heavy metals (viz. Zn, Cd, Hg, As) in industrialized areas of Gurgoan forms an important study. It is imperative to monitor the toxicity status of drinking water on regular basis to sufficiently support human health risk assessment to match international standards.

MATERIALS AND METHODS
A study was undertaken from October 2010 to October 2011 and 78 potable water samples were analysed to obtain monthly variations in the quantity of heavy metals (Pb, Cd, Hg, As) at all study sites. The study sites were chosen to give representation of all areas.

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Location of study sites with map
Location of study sites
With map is shown in figure 1
Gurgoan (Haryana)

Location 1 : Over Head Tank Kachnar Marg.
Location 2 : D.L.F Phase 1
Location 3 : Sushant Lok Colony
Location 4 : Palam Vihar Colony
Location 5 : Sec-56 Colony.
Location 6 : Sec-14 Colony.

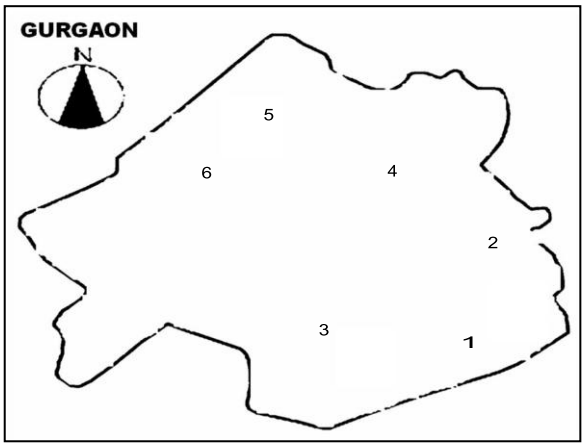

Figure 1: (Location of Study Sites)

Sampling

For analysis, sterilized plastic bottles were used which were cleaned and rinsed carefully; given a final rinse with distilled water, and sterilized in boiling water for 15 minutes. Effectiveness of sterilization was checked with each run by using sterilization strips. Sodium thiosulphate solution (75 mg Na_2SO_3 per liter of water) was added to these sampling bottles before sterilization, to dechlorinate the sample. Sometimes, this reagent was not added to the sampling bottles, then after checking for chlorine, it was added to positive samples after filter. During sample collection, sufficient air space was left in the bottle to facilitate mixing by shaking, before examination. Samples were collected that were representative of the water being tested flushed or disinfected the sample ports and used aseptic techniques to avoid contamination. Sample bottles were kept closed until filled (without rinsing) and caps were replaced immediately.

Sample Analysis

Heavy metals were determined in drinking water samples using an Inductively Coupled Plasma Mass Spectrometer. (ICPMS) – Agilent 7500.

RESULT

Pure water does not seem to exist in the nature. The contamination of water is directly related to the degree of contamination in our environment. Dangerous products from industry, agriculture and other human activities enter our natural sources of water and contaminate them. Water pollution from heavy metals has reached such an alarming level that environmentalists are finding it difficult to enforce effective control measures (WHO, 1995).

The monthly variation in the quantity of heavy metals studied at all sites is presented in Tables 1 to 6 from October 2010 to October 2011 along with quantitative report graph as obtained from ICPMS.

Lead

Scientific studies on Lead show that adverse health effects occur at lower levels of exposure to Lead than previously thought. At low levels of exposure to lead, the main health effects observed on the nervous system; specifically. Exposure to Lead may have subtle effects on the intellectual development of infants and children. Infants and toddlers are particularly vulnerable to the harmful effects of lead because they are undergoing a period of rapid development; furthermore, their growing bodies absorb lead more easily and excrete it less efficiently than adults. Once in the body, Lead circulates in the blood and either builds up in bone or is eliminated from the body, mostly in urine. Lead can stay in the body for over 30 years following exposure. Health effects associated with exposure to high levels of Lead include vomiting, diarrhea, convulsions, coma or even death (Cleveland, 2008).

The minimum and maximum values of lead in the water samples collected from different areas of Gurgoan are as follows:

Site 4 : 0.0009 ppm (June 2011)
0.01 ppm (February 2010)

Cadmium (Cd)

Drinking water with very high Cadmium levels severely irritates stomach, leading to vomiting, diarrhea and sometimes death. Consuming low level of Cadmium over a long period of time can lead to build-up of Cadmium in kidneys and causes kidney damage. It also causes bones to become fragile and break easily[8]. The minimum and maximum values of Cadmium in the drinking water samples are as follows:

Site 1	:	0.000 1 ppm	(October 2010 & January 2011)
		0.001 ppm	(August – October 2011)
Site 3	:	0.0002 ppm	(April – June 2011)
		BDL	(Oct. 2010 to March 2011 July - Oct. 2011)

*BDL (Below Detectable Level)

Table 1: Monthly Variations In Quantity Of Heavy Metals (Pb, Cd,As,Hg) Of Site 3 From October 2010 To October 2011 (Unit : Ppm)

MONTH	SAMPLE ID I-0987	Pb	Cd	As	Hg
OCTOBER 2010	(09) I	0.001	BDL	0.0002	0.004
NOVEMBER	(09) II	0.001	BDL	0.0002	0.006
DECEMBER	(09)A	0.001	BDL	0.0003	BDL
JANUARY	(09)B	0.003	BDL	0.0003	BDL
FEBRUARY	(09)C	0.001	BDL	0.0002	0.004
MARCH	(09)D	0.001	BDL	0.0002	0.006
APRIL	(41)A	0.0004	0.0002	0.0046	BDL
MAY	(41)B	0.0005	0.0002	0.0043	BDL
JUNE	(41)C	0.0005	0.0002	0.004	BDL
JULY	1-0987 (73)A	BDL	BDL	0.003	0.01
AUGUST	(73)B	BDL	BDL	0.003	0.09
SEPTEMBER	(73)C	BDL	BDL	0.003	0.01
OCTOBER 2011	(73)D	BDL	BDL	0.004	0.01

Table 2: Monthly Variations in Quantity of Heavy Metals (Pb, Cd, As, Hg) of Site 4 from October 2010 to October 2011 (Unit: Ppm)

MONTH	SAMPLE ID I-0987	Pb	Cd	As	Hg
OCTOBER 2010	(10) I	0.0007	BDL	BDL	BDL
NOVEMBER	(10) I	0.0007	BDL	BDL	BDL
DECEMBER	(10)A	0.009	BDL	BDL	0.006
JANUARY	(10)B	0.003	BDL	BDL	BDL
FEBRUARY	(10)C	0.01	BDL	BDL	BDL
MARCH	(10)D	0.0007	BDL	BDL	BDL
APRIL	(42)A	0.0015	BDL	0.0023	BDL
MAY	(42)B	0.0014	BDL	0.0013	BDL
JUNE	(42)C	0.0009	BDL	0.0026	BDL
JULY	1-0987 (74)A	BDL	BDL	0.003	0.01
AUGUST	(74)B	BDL	BDL	0.003	0.01
SEPTEMBER	(74)C	BDL	BDL	0.004	0.01
OCTOBER 2011	(74)D	BDL	BDL	0.002	0.01

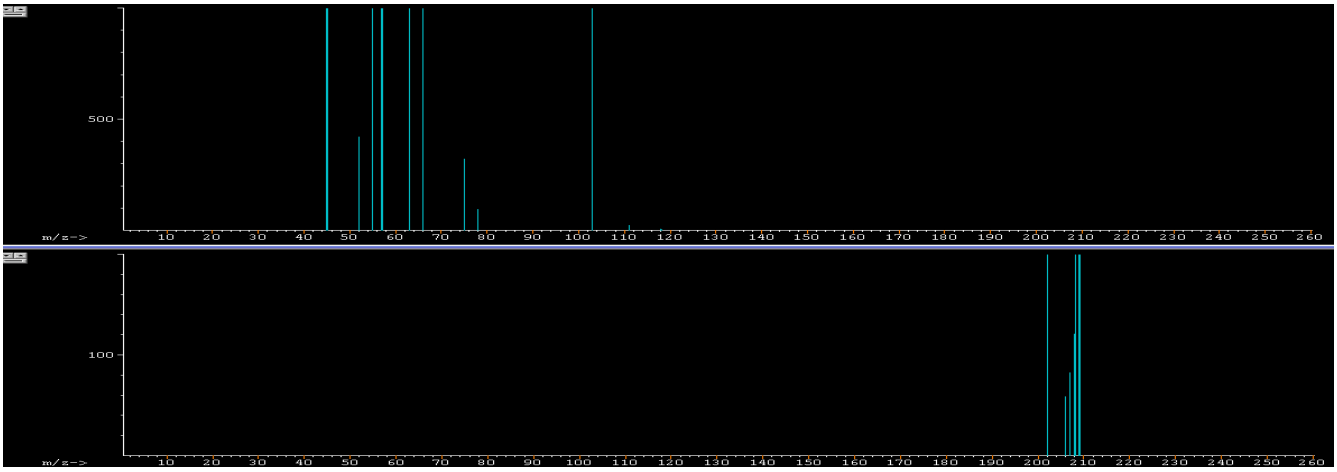

Figure 1: Quantititive Report 73 D

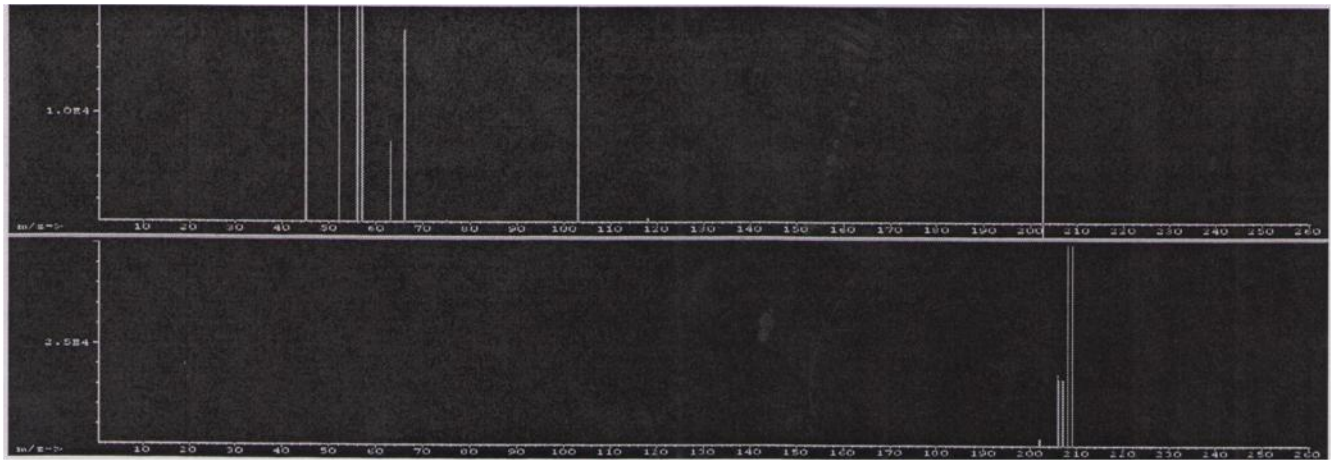

Figure 2: Quantititive Report 10 C

Arsenic (As)

Health effects from high intake of arsenic include skin damage, circulatory system problems and an increased cancer risk especially in skin, bladder and lungs. Early warnings may include stomach pain, nausea, vomiting, diarrhea and numbness in extremities (Cleveland, 2008). The minimum and maximum values of arsenic in drinking water samples collected from different areas of Gurgoan are as follows:

Site 3	:	0.0003 ppm	(Dec. 2010 - Jan. 2011)
		0.003 ppm	(July – September 2011)
Site 6	:	0.0002 ppm	(March 2011)
		0.0015 ppm	(June 2011)

Mercury (Hg)

For fetus, infants and children, primary health effect of consumption of Hg leads to impaired neurological development. In adults symptoms may include tremors, emotional changes (e.g.; mood swings, irritability, nervousness, excessive shyness), insomnia, neuromuscular changes (e.g. as weakness, muscle atrophy), headaches etc. At higher exposure it may cause kidney damage, respiratory failure and death (Zuno 2004). The minimum and maximum values of Mercury in the drinking water samples are as follows:

Site 4	:	0.00 6 ppm	(December 2010)
		0.01 ppm	(July – October 2011)

DISCUSSION

In India, drinking water standards are laid by Bureau of Indian Standards (BIS). As per Indian standard drinking water specification (IS 10500: 1991) the maximum permissible limits for toxic heavy metals are

Heavy Metals	Desirable / Required Limit in mg/L
Mercury (Hg)	0.001
Cadmium (Cd)	0.01
Arsenic (As)	0.05
Lead (Pb)	0.05

Lead the level of lead in drinking water samples ranged between 0.0009 ppm to 0.01 ppm. Drinking water samples contained lead within permissible BIS (0.05 mg/L) limits. However, WHO guidelines suggest 0.01 mg/L as the permissible limits for the presence of lead in drinking water.

Cadmium content in the drinking water samples ranged from 0.0001 ppm to 0.0002 ppm. Drinking water samples showed levels of cadmium within permissible BIS (0.01 mg/L) limits. However WHO guidelines suggested MCGL (Maximum Contamination Goal Level) and MCL (Maximum Contamination Level) values for Cadmium in drinking water as 0.005 mg/L.

Traces of Arsenic found in some water samples were within the range of 0.0002 ppm to 0.01 ppm which falls within the permissible limits of BIS *i.e.* 0.05 mg/L. However, as per WHO guidelines the MCL level for the presence of Arsenic in drinking water is 0.01 mg/L.

Traces of Mercury were found presence in some water samples which were within the range of 0.006 ppm to 0.01 ppm. All water samples showed the content of mercury within permissible BIS guidelines i.e. 0.001 mg/L. However the content of Mercury should not exceed 0.002 mg/L as per WHO guidelines.

CONCLUSION

Drinking water samples collected from Gurgoan City did not have heavy metal contamination beyond BIS permissible limit. Hence, were found fit for drinking purposes.

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