

Analysis of Heavy Metals and Pesticides in potable water supply of Industrial City of Faridabad (Haryana), India

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Abstract

Faridabad, is an industrialised city of Haryana and forms a part of National Capital Region (NCR). The fast expansion of urban, agricultural and industrial activities followed by rapid growth of population and drastic change in the lifestyle of humans has resulted in environmental pollution. Besides, the absence of proper disposal facilities for wastes has further contributed to the environmental degradation especially that of surface as well as ground water resources in our country. Exposure to heavy metals and pesticides above permissible limits have caused several incidents all over the world in which toxicity of these elements / chemicals have caused major health problems in humans and even death. The objective of the study was to investigate the occurrence of heavy metals namely : Mercury (Hg), Cadmium (Cd), Zinc (Zn), Arsenic (As) and pesticides namely : Chlorobenzilate, Hexachloro-benzene, Benzenether, pp-DDT, op-DDT, pp-DDE, pp-DDD, alpha-HCH, Beta-HCH, Lindane, Vinclozolin, Conumaphos, Malathion, Phosalone, Cyfluthrin, Cypermethrin, Deltamethrin, Permethrin, Fenvalerate, Fluvalinate, Cyhalothrin, Carbofurn, Propoxeur, Carbaryl, Cymiazol, Amitraz, Bromprophylate, Chinomethionate in potable (tap) water samples collected from various areas of Faridabad.

Key words : Potable Water, Pesticides, Heavy Metals, National Capital Region (NCR), Faridabad.

Introduction

Water is an important resource for the

survival of mankind. People from all around the world use surface as well as ground water for drinking purpose and over the years the

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demand for good quality potable water has increased manifold. Due to population explosion and industrialization, our sources of water are being constantly exploited due to discharge of domestic wastes, fertilizers, pesticides, untreated industrial effluences etc. which has resulted in the overall the deterioration in the quality of potable water¹. Heavy metal can enter our potable water through a variety of sources which may be natural like weathering, dissolution of aerosol particles from the atmosphere, leaching of soil etc. or anthropogenic like mining, electroplating, burning of fossil fuels, processing of metals *etc*²⁻³.

Some trace metals are essential for maintaining human body metabolism, but in higher concentration they may have toxic effects on the body. One of the main aspects of risk to the human health with the exposure of heavy metals through potable water that can possible have carcinogenic effect on human body is being studied all over the world by various researches⁴.

Pesticides are chemical substances used for controlling pests, unwanted species of plants, vectors of human and animal diseases, plant growth regulators *etc*⁵.

Pesticides that are applied on crops may be washed away from application site by rain, before the pesticides binds or degrades, it is carried to surface water sources or may seep deep into the soil during recharge and get into aquifers. Pesticides are sometimes directly applied on lakes and wetlands for the control of aquatic weeds, insects or fish. Sometimes pesticides can move in air from application site to surface waters. Pesticides can get into

drinking water when humans dump unused pesticides down the drain. In water treatment plants, antimicrobial pesticides are added during water treatment to prevent water borne diseases⁶.

Due to intensive industrial and agricultural practices taking place in and around Faridabad, it is likely that various heavy metals and pesticides are used and there are chances that they might have reached our drinking water sources and are persistent in our drinking water system. So, it becomes imperative to detect the presence of pesticides and heavy metals in potable water as it is of utmost concern to human health.

Experimental

A study was undertaken from October 2010 to October 2011 and 65 potable water samples (tap water) were analysed to obtained monthly variations in the quantity of heavy metals and pesticides at all study sites. The study sites were chosen to give representation of all areas.

LOCATION OF STUDY SITES WITH MAP :

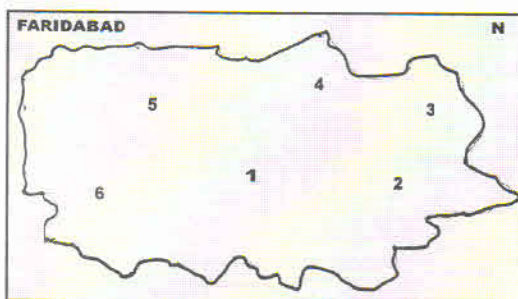


Figure 1 (Location of Study Sites)

Geographical Coordinates of Faridabad are :
 28°25'16"N 77°18'28"E/28.4211°N 77.3078°E
 / 28.4211; Location of Study Sites with Map is
 Shown in Fig. 1

FARIDABAD (HARYANA)

Location 1 : NIT, Nehru Ground.

Location 2 : Sector 35 Colony.

Location 3 : Sector-21, A Colony.

Location 4 : Sector-23, Industrial Area.

Location 5 : Sector-19, Industrial Area.

SAMPLING

Sampling for water analysis was done aseptically with care, ensuring that there was no external contamination of samples. For analysis, sterilized plastic bottles were used which were sterilized by boiling for 15 minutes and rinsed with distilled water. Effectiveness of sterilization was checked with each run by using sterilization strips (commercially available) inside sampling bottles. During sample collection, some air space was left in the bottle to facilitate mixing by shaking, before examination. Tap is open fully and water was allowed to run for 2-3 minutes and then flow of water was reduced to permit filling of water samples.

SAMPLE ANALYSIS

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

Pesticides were detected in drinking water samples by Gas Chromatography Mass

Spectrometer (GCMS) Thermo Finnigan.

RESULT **Pesticides:**

Pesticides in potable water can cause a variety of adverse health effects. They can cause acute and delayed health effects to those who are exposed to them. These effects may range from irritation of eyes are skin, more severe effects such as affecting the nervous system, genetic changes, blood disorder, endocrine disruption, production of benign and malignant tumors, birth defects, fetus deaths or can also have carcinogenic effect in many cases.

Individual pesticides might have toxic effect on humans. Variation exists in the toxicity of pesticides and the sensitivity of people to chemicals. Most pesticides will have toxic effects on animals at high levels, some parasites are toxic at medium or low levels. Pesticides in drinking water are usually found at very low levels⁷.

All 65 drinking water samples collected from all the sites through out the year were investigated for the occurrence and content of pesticides viz. : Chlorobenzilate, Hexachlorobenzene, Benzenether, pp-DDT, op-DDT, pp-DDE, pp-DDD, alpha-HCH, Beta-HCH, Lindane, Vinclozolin, Conumaphos, Malathion, Phosalone, Cyfluthrin, Cypermethrin, Deltamethrin, Permethrin, Fenvalerate, Fluvalinate, Cyhalothrin, Carbofurn, Propoxeur, Carbaryl, Cymiazol, Amitraz, Bromprophylate, Chinomethionate. However, no drinking water samples tested positive for the presence of any of these pesticides *i.e.* no pesticides were present in the samples of potable water.

Heavy Metals

The monthly variations in the quantity of heavy metals studied at all sites are presented in Tables 1 to 5 from October 2010 to October 2011 along with quantitative report graph as obtained from ICPMS.

a) Lead: Increasing environmental exposure to Lead can cause serious haematological and neurological effects on humans which draws our attention towards regularly investigating Lead levels in our potable water system. Lead is derived from the effects of soft water on the pipes or pollution industries pollution. Lead levels in drinking water can pose a serious concern to human health⁸.

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

Site 1 :	0.0005 ppm	(June 2011) –
	0.001 ppm	(March 2011) to
Site 2 :	0.0007 ppm	(June 2011) –
	0.05 ppm	(March 2011)

(b) Cadmium (Cd): Higher Cadmium levels in potable water severely irritates stomach, causes vomiting, diarrhea and sometimes even death occurs. Consuming low levels of Cadmium over a long period of time can lead to build-up of Cadmium in kidneys and causes kidney damage. It may cause fragility of bones which make them prone to breakage⁹. The minimum and maximum values of Cadmium in the drinking water samples, are as follows:

Site 2 :	0.0001 ppm	(March 2011) –
	BDL (Below Detectable Level)	
Site 3 :	0.0014 ppm	(April 2011)–
	BDL (Below Detectable Level)	

(c) Arsenic (As) : If humans consume lower amounts of Arsenic (ranging from 300 to 30,000 ppb), they may experience irritation in stomach and intestines with symptoms such as stomach ache, nausea, vomiting and diarrhea. At a large doze (above 60,000 ppb) it can result in death¹⁰. Long term exposure to Arsenic can cause darkening of skin and appearance of small corns or warts on the palms, soles, torso and change in blood vessels of skin¹¹.

The minimum and maximum value of heavy metals in the water samples collected from different areas of Faridabad are as follows :

Site 2 :	0.0007 ppm	(May 2011) –
	0.002 ppm	(October 2011) to
Site 5 :	0.0005 ppm	(November 2010)–
	0.0012 ppm	(June 2011)

(d) Mercury: Exposure to inorganic mercury is associated with tremors, gingivitis, minor psychological changes, spontaneous abortions and congenital malformation¹². The minimum and maximum values of mercury in the drinking water samples are as follows :

Site 1 :	0.006 ppm	(June 2011) –
	0.01 ppm	(August 2011)

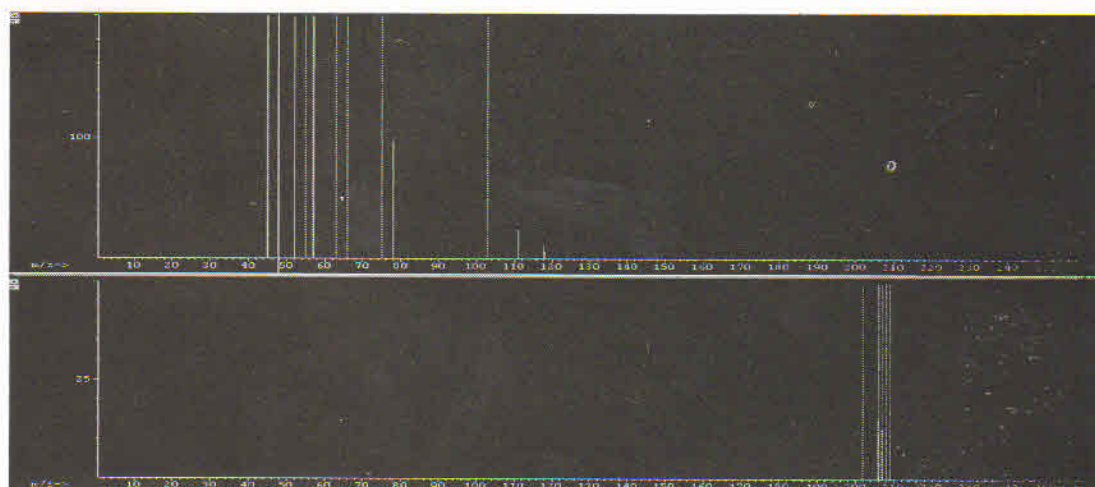
Discussion

Pesticides :

The standard for individual pesticides has been described at 0.001 mg/L and for total pesticides at 0.0005 mg/L as per BIS (IS 10500: 1991) guidelines. WHO has proposed guidelines for some pesticides, however there are no guidelines for majority of pesticides. Drinking water samples collected from various areas of Faridabad did not contain any pesticides.

Table 1. MONTHLY VARIATIONS IN QUANTITY OF HEAVY METALS
(Pb, Cd, As, Hg) OF SITE 1 FROM OCTOBER 2010
TO OCTOBER 2011 (UNIT : ppm)

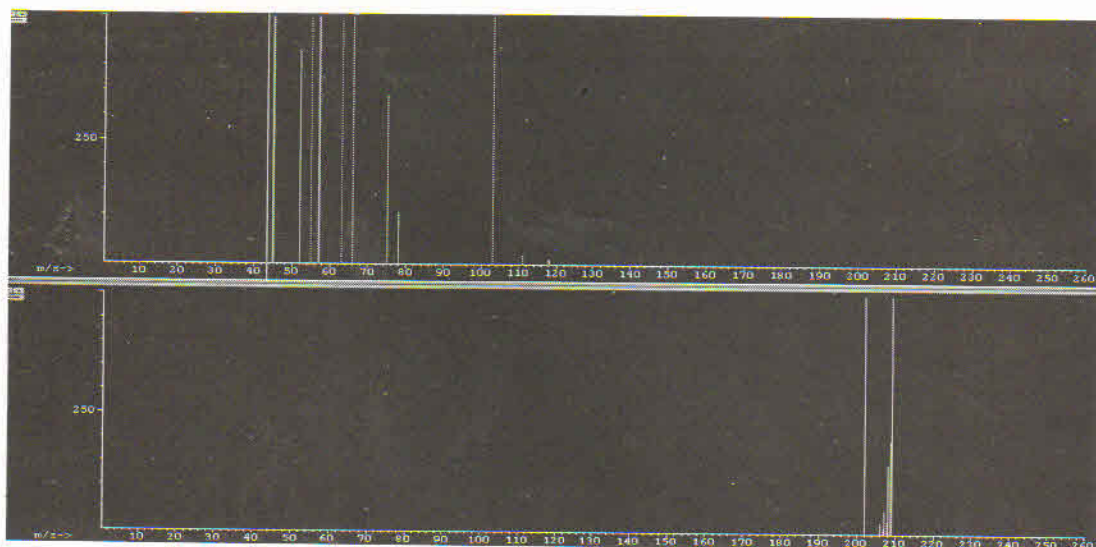
MONTH	SAMPLE ID I-0987	Pb	Cd	As	Hg
October 2010	(11) I	0.003	BDL	BDL	0.006
November	(11) II	0.001	BDL	BDL	BDL
December	(11) A	0.002	BDL	BDL	BDL
January	(11) B	0.003	BDL	BDL	0.006
February	(11) C	BDL	BDL	BDL	BDL
March	(11) D	0.001	BDL	BDL	BDL
April	(43) A	0.0004	BDL	0.0007	BDL
May	(43) B	0.0005	BDL	0.0004	BDL
June	(43) C	0.0005	BDL	0.0008	BDL
July	1-0987 (75) A	BDL	BDL	0.002	0.01
August	(75) B	BDL	BDL	0.004	0.01
September	(75) C	BDL	BDL	0.003	0.01
October 2011	(75) D	BDL	BDL	0.003	0.01



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Table 2. MONTHLY VARIATIONS IN QUANTITY OF HEAVY METALS
(Pb, Cd, As, Hg) OF SITE 2 FROM OCTOBER 2010
TO OCTOBER 2011 (UNIT : ppm)

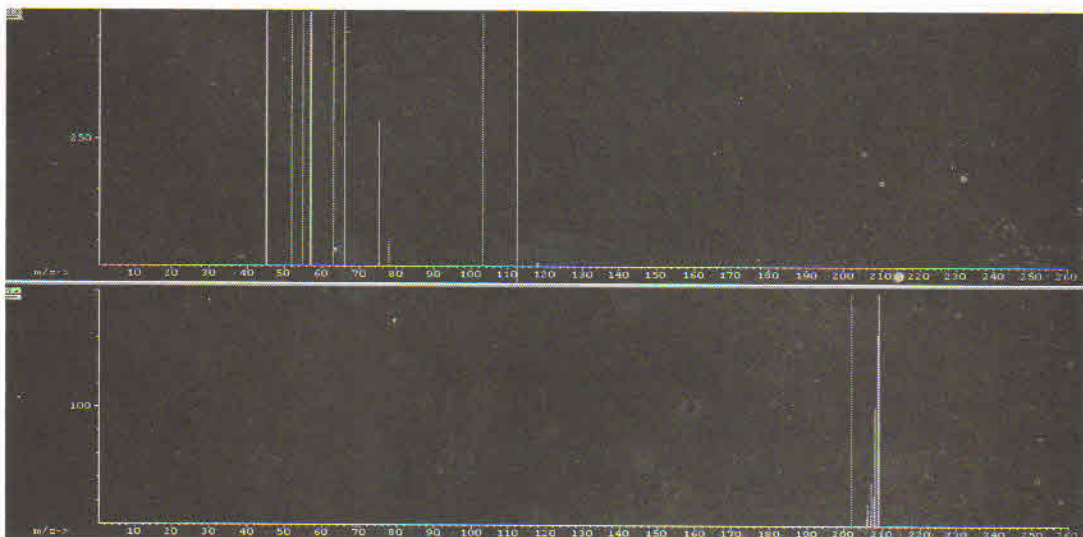
MONTH	SAMPLE ID I-0987	Pb	Cd	As	Hg
October 2010	(12) I	0.0007	BDL	0.0001	BDL
November	(12) II	0.0005	BDL	0.0001	BDL
December	(12)A	0.0005	BDL	0.0001	BDL
January	(12)B	0.0007	BDL	0.0001	BDL
February	(12)C	0.007	BDL	0.0002	BDL
March	(12)D	0.05	0.0001	0.0003	BDL
April	(44)A	0.0007	BDL	0.0007	BDL
May	(44)B	0.0006	BDL	0.0007	BDL
June	(44)C	0.0007	BDL	0.0005	BDL
July	1-987(76)A	BDL	BDL	0.002	0.01
August	(76)B	BDL	BDL	0.002	0.01
September	(76)C	BDL	BDL	0.002	0.01
October 2011	(76)D	BDL	BDL	0.002	0.01



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Table 3. MONTHLY VARIATIONS IN QUANTITY OF HEAVY METALS
(Pb, Cd, As, Hg) OF SITE 3 FROM OCTOBER 2010
TO OCTOBER 2011 (UNIT : ppm)

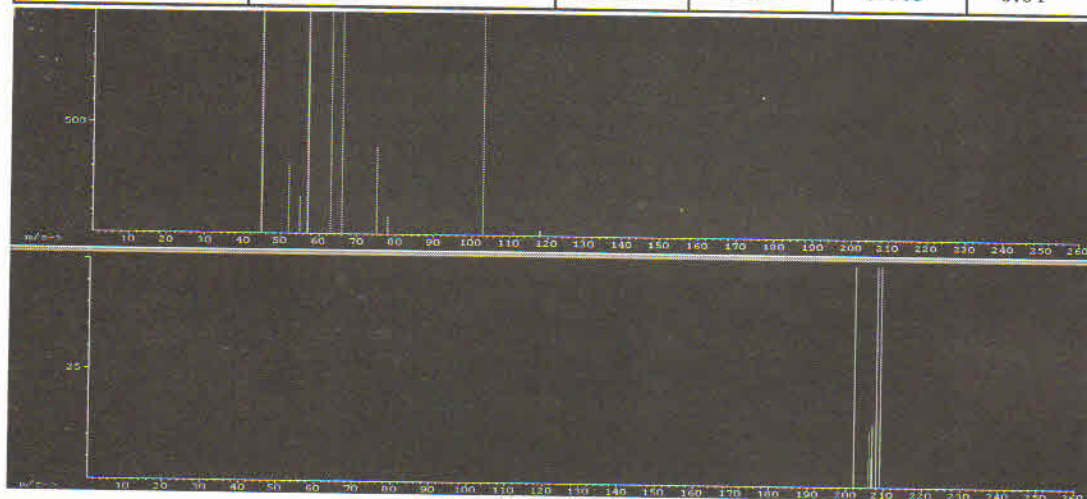
MONTH	SAMPLE ID I-0987	Pb	Cd	As	Hg
October 2010	(13) I	0.003	BDL	0.0001	BDL
November	(13) II	0.02	BDL	0.0002	BDL
December	(13)A	0.003	BDL	0.0001	BDL
January	(13)B	0.02	BDL	0.0002	BDL
February	(13)C	0.01	BDL	0.0002	0.003
March	(13)D	0.001	BDL	0.0002	BDL
April	(45)A	0.0005	0.00014	0.0025	BDL
May	(45)B	0.0003	BDL	0.0013	BDL
June	(45)C	0.0005	BDL	0.0012	BDL
July	1-987(77)A	BDL	BDL	BDL	0.01
August	(77)B	BDL	BDL	BDL	0.01
September	(77)C	BDL	BDL	BDL	0.01
October 2011	(77)D	BDL	BDL	0.008	0.01



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Table 4. 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	(14) I	0.001	BDL	0.0001	BDL
November	(14) II	0.001	BDL	0.0002	BDL
December	(14)A	0.003	BDL	0.0002	BDL
January	(14)B	0.001	BDL	0.0001	BDL
February	(14)C	0.001	BDL	0.0002	BDL
March	(14)D	0.003	BDL	0.0002	BDL
April	(46)A	0.0003	BDL	0.0011	BDL
May	(46)B	0.0004	BDL	0.0014	BDL
June	(46)C	0.0003	BDL	0.0018	BDL
July	1-987(78)A	BDL	BDL	0.003	0.01
August	(78)B	BDL	BDL	0.003	0.01
September	(78)C	BDL	BDL	0.007	0.01
October 2011	(78)D	BDL	BDL	0.003	0.01



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1. Heavy Metals :

The monthly variations in the quantity of heavy metals studied at all sites are presented in Tables 1 to 5 from October 2010 to October 2011 along with quantitative report graph as obtained from ICPMS.

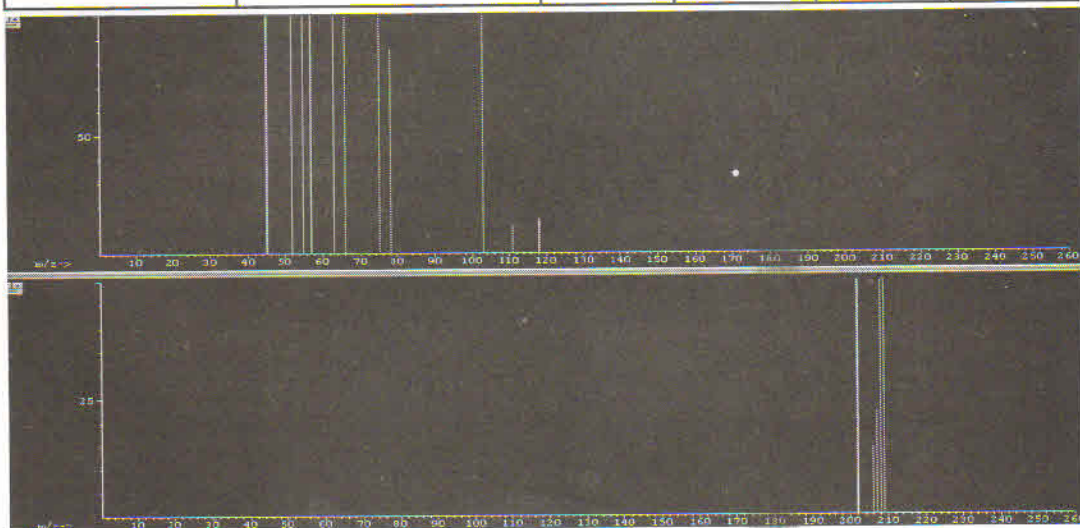
In India, drinking water standards are laid by Bureau of Indian Standards (BIS and

WHO). As per Indian standard drinking water specification (IS 10500 : 1991) the maximum permissible limits for toxic heavy metals are :

Heavy Metals	Desirable / BIS Required Limit in mg/L	WHO Required Limit in mg/L
Mercury (Hg)	0.001	0.002
Cadmium (Cd)	0.01	0.0005
Arsenic (As)	0.05	0.01
Lead (Pb)	0.05	0.01

Table 5. MONTHLY VARIATIONS IN QUANTITY OF HEAVY METALS (Pb, Cd, As, Hg)
OF SITE 5 FROM OCTOBER 2010 TO OCTOBER 2011 (UNIT : ppm)

MONTH	SAMPLE ID I-0987	Pb	Cd	As	Hg
October 2010	(15) I	0.003	BDL	0.0001	BDL
November	(15) II	0.004	BDL	0.0001	BDL
December	(15)A	0.004	BDL	0.0001	BDL
January	(15)B	0.003	BDL	0.0001	BDL
February	(15)C	0.004	BDL	0.0001	BDL
March	(15)D	BDL	BDL	BDL	BDL
April	(47)A	0.0015	BDL	0.0015	BDL
May	(47)B	0.0007	BDL	0.0014	BDL
June	(47)C	0.0002	BDL	0.0037	BDL
July	I-987(79)A	BDL	BDL	0.003	0.01
August	(79)B	BDL	BDL	0.002	0.01
September	(79)C	BDL	BDL	0.003	0.01
October 2011	(79)D	BDL	BDL	0.002	0.02



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(a) **Lead** the level of lead in drinking water samples ranged between 0.0009 ppm to 0.01 ppm. All drinking water samples contained Mercury within BIS / WHO permissible limits.

(b) **Cadmium** content in the drinking water samples ranged from 0.0001 ppm to 0.0014 ppm which falls within the permissible

limits of BIS / WHO.

(c) Traces of **Arsenic** found in some water samples was within the range of 0.0007 ppm to 0.0012 ppm which falls within the permissible limits of BIS / WHO.

(d) The levels of **Mercury** in drinking

water samples ranged from 0.006 to 0.01 ppm. However, all drinking water samples contained Mercury within BIS / WHO permissible limits.

Conclusion

Drinking water samples collected from Faridabad city did not have any heavy metal and pesticides contamination beyond BIS permissible limits. Hence, were found fit for drinking purpose.

Acknowledgement

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