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Estimation of heavy metals, lead and nickel in water samples of some water bodies of industrial Town Faridabad

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Abstract

Faridabad is an industrial hub and Industries release their toxic effluents in the nearby water bodies. To find out the impact of industrial effluents in water, an attempt was made to analyse the heavy metals, lead and nickel in water samples at different sites ranging from drains to their confluence with Buriah Nullah and finally river Yamuna. Water samples were also collected from fish ponds at villages near Faridabad. Heavy metals were estimated in water samples by Atomic Absorbtion Spectroscopy. Lead is a highly poisonous element which has serious adverse impacts on the environment as well as human beings. Heavy metal nickel is essential in small quantities but an uptake of too large quantities of nickel results in higher chances of development of various types of cancer and allergic reactions. Higher concentration of Pb and Ni in water samples beyond their permissible limit is a potent danger for aquatic life and human health as these heavy metals are highly persistant and biomagnify in the food chain.

Keywords: Lead (Pb) | Nickel (Ni) | Biomagnify | River Yamuna

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Introduction

Water is not only the most important essential constituent of all animals, plants and other organisms but also pivotal for the survivability of mankind in the biosphere (Muthulakshmi, L. *et al.,* 2009). Safe and good quality drinking water is the basis for good human health (Balakrishnan A. *et al.,* 2014). Water provides some elements, but when polluted it may prove dangerous to human health and cause diseases such as various cancers, adverse reproductive outcomes, cardiovascular diseases and neurological disorders (Karavoltsos S. *et al.,* 2008). There are many cases identified with the harmful effects of mercury, lead and arsenic on human health, in several parts of the world. Those incidents have prompted numerous investigations into the metabolism and toxic effects of these three elements (Matta, 2014;

Matta *et al.,* 2015a; Matta & Gjyli, 2016). Several factors such as climate, characteristics of soil, circulation of ground water through rock types, topography of the area, human activities on the ground *etc*. poses several effects on the quality of water (Annapoorani A. *et al.,* 2012). Also it will adversely affect the living organism while entering into the food chain (Matta *et al.,* 2015b; Matta *et al.,* 2016).

Faridabad industrial complex occupies a significantly important place on the industrial map of India. Faridabad is the industrial hub being 9th biggest industrial town in India. It has various types of industries manufacturing products ranging from hypodermic syringes to huge mechanized loaders, tractors, motorcycles, air conditioners, tyres *etc*. A large number of textiles, dyeing and printing units have also come up in this industrial complex during last few years which release toxic effluents including heavy metals, lead (Pb), cadmium (Cd), nickel (Ni), mercury (Hg) etc. which are blatantly discharged into water bodies. Faridabad also has lots of lead smelting plants, lead acid battery manufacturing units which release lot of lead in its effluents. Lead is a highly poisonous element which has serious adverse impacts on the environment as well as human beings. Lead (Pb) is one of the most toxic of heavy metals and its compounds are included in the grey list of international conventions (Taylor *et al.,* 1985). Lead that is emitted into the atmosphere can be inhaled, or it can be ingested after it settles out of the air. It is rapidly absorbed into the bloodstream and is believed to have adverse effects on the central nervous system, cardiovascular system, kidneys, and the immune system (Bergeson, Lynn L., 2008).

Nickel is essential in small quantities, but when the uptake is too high it can be a danger to human health. The primary sources of nickel emissions into the ambient air are the combustion of coal and oil for heat or power generation, nickel mining, steel manufacture, and miscellaneous sources, such as cement manufacturing. It is also used extensively in electroplating as nickel sulphate and nickel hydroxide is used in nickel–cadmium batteries (Nanda and Behera, 1996). Electroplating units are also established in Faridabad in large numbers which result in nickel discharge into water.

Humans may be exposed to nickel by breathing air, drinking water, eating food or smoking cigarettes. Nickel uptake will boost when people eat large quantities of vegetables from soils irrigated with polluted water. Plants are known to accumulate nickel and as a result the nickel uptake from vegetables will be eminent. An uptake of too large quantities of nickel results in higher chances of development of lung cancer, nose cancer, larynx cancer and prostate cancer, sickness and dizziness after exposure to nickel gas, lung embolism, respiratory failure, birth defects, asthma and chronic bronchitis , allergic reactions such as skin rashes, mainly from jewellery, heart disorders. Nickel fumes are respiratory irritants and may cause pneumonitis.

An attempt is made in the present research to determine the concentration of heavy metals lead and nickel in water samples collected from drains of Faridabad carrying industrial

effluents and finally merging in the holy river Yamuna.

Materials and Method

Collection and Preservation of Water Samples

Water was collected in clean Larson polyethylene bottles which were washed thoroughly first with dilute hydrochloric acid and then with tap water. For collection of samples from depth of water sampler thermos bottle was used. Two litres of water sample was collected from each point. The samples were labelled and preserved for analysis. For preservation of water samples for heavy metal analysis water samples were filtered through wattman 42 filter paper. The samples were then digested with 5m/litre of double distilled reagent grade HNO_3. The bottles were shaken to allow the escape of CO_2. The stopper was tightly put and bottles were properly labelled (APHA).

Sample Analysis By Atomic Absorbtion Spectroscopy

Atomic absorption Spectroscopy is an optical technique based on characteristic pattern of emission or absorption of light by atom or molecules and suitable for estimation of most metals (Curry *et al.,* 1969). For analysis 3 ml of water sample was taken in test tube and 7 ml of mixture $HCl:HNO_3:H_2O$ in ratio of 1:1:1 was added. It was then digested on hot plate slowly until most of the acid was evaporated and a pasty mass remained. The substrate was allowed to cool and mixed with 25 ml of distilled water. After rigorous shaking, it was kept overnight to settle. Atomic absorption measurements were carried out and the calculations were made (Lindsay, W.L. and Norwell, W. A., 1978).

The analyzed concentration expressed as the % of the metal is calculated from the following formula

$$X=m\ x100/M$$

X - Standard for the weight of the metal in the sample

m - Mass in microgram of the metal per millilitre of the solution (obtained from reading)

M - Mass in microgram per ml of the sample in the test solution.

Observation and Results

Faridabad is most densely populated district of Haryana state and industries release their toxic effluents in the nearby water bodies. To find out the impact of industrial effluents in water, an attempt was made to analyse the heavy metals, lead and nickel in water samples at different sites ranging from drains to their confluence and finally river Yamuna (Table-I).Water samples collected from drain coming from Faridabad and 100 meters before its confluence with Buriah Nullah had 8.00 ppm lead content and 2.15 ppm nickel content. Lead content was found to be maximum in the water samples of the drains confluence at Buria Nullah *i.e.* 16.02 ppm and nickel content was 2.92 ppm. The drain coming from Delhi and joining Buriah Nullah had 4.41 ppm lead

and 3.85 ppm nickel. In the water samples collected from the Rajiv Nagar drain highway bypass 6.00 ppm lead and 4.35 ppm nickel was found. The concentration of nickel was found to be maximum (4.55 ppm) in the water samples collected from 100 meter before confluence of Buriah Nullah and Yamuna upstream. However at the confluence of Buriah

Nullah and river Yamuna, lead and nickel concentration in water sample was reduced to 2.50 ppm and 3.80 ppm respectively. Lead and nickel concentration further reduced to 2.12 ppm and 3.20 ppm respectively in the Yamuna downstream towards Mathura.

Fish ponds are artificially excavated water bodies and are used to rear fish by the local farmers. Water samples from some fish ponds were collected and tested for concentration of heavy metals, lead and nickel which beyond threshold level can be potentially dangerous to aquatic life as well as human beings. Water samples were collected from fish ponds at villages near Faridabad on route from Buriah Nullah to Yamuna and their heavy metal content is described below in the tables II and III.

Lead and nickel content was found to be maximum in surface and sub surface water of fish ponds located at village Nacholi. The concentration of lead was found to be 8.82 ppm in subsurface water and 7.71 ppm in the surface water. The nickel content was more in subsurface water 5.01 ppm than in surface water *i.e.,* 4.03 ppm. The lead and nickel contents were found to be least in water samples collected from fish ponds at village Kanwara. Here the lead content was 2.40 ppm in subsurface water and 1.60 ppm in surface water. Nickel content was 1.50 ppm in subsurface water and 1.25 ppm in surface water. The concentration of lead and nickel in the subsurface water of fish ponds located at Bhopani and Kheri was very close to each other. The lead concentration in surface water of fish ponds at Bhopani and Kheri was 2.90 ppm and 3.30 ppm respectively while nickel content was 2.42 ppm and 1.85 ppm in fish ponds at Bhopani and Kheri respectively. The concentration of lead was found to be more as compared to nickel in all water samples.

Discussion

The present population of District Faridabad is generating 200 MLD of sewage per day and the combined capacity of existing Sewage Treatment Plants owned by Municipal corporation, Faridabad and PWD (water supply and sanitation Department) is 115 MLD (Million Litres per Day). The rest of 85 MLD of domestic sewage is being discharged to river Yamuna without any treatment through Buriah Nullah and other drains.

There are 12468 registered industries in District Faridabad and the number of polluting industrial units is 367. All these units have installed effluent treatment plants in their premises to treat the trade effluent generated. The treated trade effluents are being discharged into sewer which finally find its way to river Yamuna. Before reaching the river Yamuna the industrial effluent passes through 3 number of Sewage Treatment Plant (STP) as terminal treatment facility installed by Public Health Department / Municipal Corporation Faridabad. A part of the untreated industrial trade effluent is being discharged into the drains and Buriah Nullah which is not treated by the STP and finally reaching river Yamuna. None of these drains carrying domestic effluent, industrial effluent and surface run off has been lined. So the quality of underground water is also deteriorating due to contamination through leaching. Infrastructure

for treating contaminated surface run off during rainy season is not existing therefore the contaminated water is directly reaching river Yamuna (Haryana State Pollution Control Board).

Acidification of soils, ponds and lakes may result in enhanced mobilization of heavy metals from soils and sediments and leads to increased levels in surface and ground water (WHO, 1985). The heavy load of metals in the soil ultimately reaches the water bodies and affects the aquatic biota and ground water quality. The probable source of contamination could be inputs of domestic waste and waste water from industrial units.

S. No.	Site Of Collection	Lead (Ppm)	Nickel (Ppm)
1.	Drain coming from Faridabad 100m before its confluence with Buriah Nullah	8.00±1.90	2.15±0.09
2.	Drains confluence at Buria Nullah	16.02±2.65	2.92±1.17
3.	Drain from Delhi at Buria Nullah	4.41±1.25	3.85±2.12
4.	Rajiv Nagar Drain Highway Bypass	6.00±1.39	4.35±2.69
5.	100 meters before confluence of Buriah Nullah and Yamuna upstream	2.87±0.92	4.55±1.75
6.	Confluence of Buria Nullah and Yamuna	2.50±1.19	3.80±1.53
7.	Yamuna downstream towards Mathura	2.12±1.31	3.20±2.05

Values are mean±SD, n=6

Table 1: Lead And Nickel Content In Water Samples Collected From Different

Site Of Collection	Lead (Ppm)	Nickel (Ppm)
Fish pond at Kanwara	2.40±0.02	1.50±0.03
Fish pond at Bhopani	3.20±.14	2.30±0.07
Fish pond at Kheri	3.31±0.11	2.20±0.15
Fish pond at Nacholi	8.82±0.25	5.01±0.22

Values are mean±SD, n=6

Table 2: Lead and nickel content in subsurface water of fish ponds Sites

Site of collection	Lead(ppm)	Nickel(ppm)
Fish pond at Kanwara	1.60±0.02	1.25±0.79
Fish pond at Bhopani	2.90±0.49	2.42±1.72
Fish pond at Kheri	3.30±1.13	1.85±0.09
Fish pond at Nacholi	7.71±0.68	4.03±2.57

Values are mean±SD, n=6

Table 2: Lead and nickel content in surface water of fish ponds Sites

Lead enters the aquatic environment through erosion and leaching from soil, lead dust fall out, combustion of gasoline, municipal and industrial waste discharges, runoff water deposits from streets and other surfaces as well as precipitation (Department of water and Forestry (D.W.A.F), 1996). Galvin (1996) reported that in natural water, the total lead concentration generally range between 0.05 and 10mg/l.

Electroplating is considered a major pollution activity because it discharges toxic materials and heavy metals through waste water, air

emissions and solid wastes into the recipient environment. Andhra Pradesh pollution Control Board (APPCB, 2004) carried out a detailed water survey in electroplating units established and found that only 10-15% of the heavy metals, nickel and chromium added as input is obtained as useful output product and as much as 70-75% of the material ends up in the waste stream in addition to 10-15% losses as toxic fumes.

The larger portion of all the nickel compounds that are released into the environment will be adsorbed by the sediment or soil particles and become immobile as a result. In acidic ground however, nickel is bound to become more mobile and it will often rinse out to the ground water. Khurshid *et al.,* (1997) also reported degradation of ground water quality due to heavy metals in Faridabad district, Haryana. Solid waste from industrial belt of Faridabad is dumped near the factories, which is subjected to reaction with percolating rain water and reaches the ground water level. The percolating water picks up a large number of heavy metals and reaches the aquifer system and contaminates the ground water. It was also reported that samples collected from shallow aquifers shows higher concentration of heavy metals than those from deeper aquifers.

Conclusion

In the present study as the concentration of Lead and Nickel in water samples tested from different water bodies is beyond the permissible limits as recommended by WHO (0.01mg/l for Pb and 0.02mg/l for Ni). So water from these sites is unfit for consumption by humans as well as highly toxic for the aquatic flora and fauna for their survival and for human intake.

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