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SEASONAL VARIATION OF HEAVY METAL CONCENTRATION IN WATER SAMPLES FROM DIFFERENT FRESH WATER BODIES IN AND AROUND COIMBATORE DISTRICT.

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Abstract

The levels of heavy metals in the water can be deliberated as a serious matter of disquiet as it may be consumed and it signifies the degradation of water quality. The present study was carried out to investigate the seasonal variation of heavy metal contamination in fresh water bodies from Coimbatore region, during 2018-2019. Heavy metals in water samples were analyzed by Atomic Absorption Spectroscopy (AAS). There was an appreciable increase in metal concentration from the water samples collected from the selected study areas. The metal concentration in water samples during the present study was in the following order based on their abundance; Zn > Cu > Ni> Cd>Cr> Pb. In general, the sources of heavy metals in fresh water bodies could be attributed to the illegal activity of waste dumping and discharges from the nearby sewage treatment plant into that freshwater ecosystem which enhances the process of eutrophication, finally leads to degradation of water quality. This indicates the level of risk to human health. So there is a need for a constant monitoring of the heavy metals concentrations in the fresh water ecosystem.

Key words: Fresh water, pollution, seasonal variation, heavy metal contamination.

Introduction

Water is a key resource for agriculture, casting and other human activities. It is the most prominent one to the mankind and there is no possibility of life on earth without water. Water on earth is the primary source and an essential element for all living beings. It is mainly used for various activities like drinking, irrigation, fish production, industrial cooling, power generation and many others (Sathe *et al.*, 2001).

The widen activity of an environmental contamination by toxic substances in a freshwater ecosystem is a growing concern. An ample range of contaminants are frequently introduced into the aquatic environment mainly due to increased industrialization, technology development, over population, manipulation, agricultural and domestic wastes run-off. Among these contaminants, heavy metals are considered as a major factor because of their persistent nature, adverse toxic effect and its bio accumulating capacity in the aquatic environment. Heavy metals are non- degradable substances which are main constituents of an environment in a minimum quantity of the natural ecosystem. Apart from the natural sources anthropogenic activities are the major source of heavy metal contamination. Among the heavy metals some are potentially toxic (As, Cd, Pb, Hg, etc.), some are probably essential (Ni, V, Co) and some are essential (Cu, Zn, Fe, Mn) (Munoz-Olivas and Camara, 2001). Toxic elements can be very harmful even at low concentration if they consumed for a long period.

The presence of metal contaminants in freshwater will confuse the gentle balance of the aquatic system, which may reduce the water quality, availability of food and finally affect the organism present in that. About 80% of all diseases in developing countries are caused by contaminated water. So there is a need to monitor the level of water pollution in regular intervals. With this concern the present study was aimed to determine the concentration of some heavy metals (Cd, Cr, Cu, Ni, Pb and Zn) in water samples from selected wetlands (W-I, W-II ,W-III) in and around Coimbatore district.

Materials and methods

Study area

Coimbatore is the second largest city in the Indian state of Tamil Nadu, located at 11°00′58″N 76°58′16″E11.0161°N 76.971°E, surrounded by the Western Ghats. More than 40,000 small, medium and large industries including textiles, mills, automotive components and other manufactured goods in the city employing about 50% of the population. Because of its industrial activities the city is known as Manchester of south. The city is mainly fed by Noyyal river, a seraphic and sanctified river which arises from the Vellingiri hills of Western Ghats. The local people used Noyyal river for irrigation, and other activities. There are 28 wetlands in Coimbatore city which are mostly fed by Noyyal river.

Three wetlands falling in and around the city limits were selected for the present study. (Plate 1). They are namely Perur wetland (W-I), Sulur wetland (W -II) and Orathupalayam wetland (W-III). The present work on these wetlands (study areas) from in and around Coimbatore district was spanned from March (2018) to February (2019).

Collection of water samples for heavy metal analysis

The sampling bottles were pre-conditioned with 5% nitric acid and later it was rinsed thoroughly with distilled de-ionized water. At each sampling site, the sampling bottles (polyethylene) were rinsed at least twice or three before sampling was done. Pre-cleaned and labeled sampling bottles were immersed about 10 cm below the water surface. About 0.5 L of the water samples were taken from each sampling site. Collected samples were acidified with 10% $HNO3$, kept in an ice-cold box and immediately transported to the laboratory. The samples were filtered through a 0.45 µm micropore membrane filter and kept at 4 °C until analysis. The samples were analyzed directly by using Atomic Absorption Spectrophotometer (AAS).

All chemicals which were used for the preparations of reagents for present analysis were AR grade and double distilled water was used for preparation of solutions. The laboratory apparatus and class wares were soaked in nitric acid before analysis and then rinsed thoroughly with tap water and deionized distilled water to ensure any traces of cleaning reagents were removed.

Statistical analysis

All the data were analyzed statistically by calculating Mean and Standard Deviation with 0.05% significant level.

Result

The results for the heavy metals analyzed have been summarized below. Six heavy metal including both 3 essential and 3 non-essential were selected for the present study and the data obtained and they were compared with standard guidelines. **Table- 1**

In the present investigation mean concentration of Cu was high 126.76± 4.251 µg/L in W-III during monsoon season while during summer season it was low in W-I (42.31±2.542) µg/L. The Ni concentration during the present investigation was recorded high in W-III (59.54± 3.047) µg/L and low in W-I (22.40± 1.013) µg/L. Zn concentration of analyzed water sample during the study period showed high values in W-III (279.89± 3.047) µg/L during monsoon season while it was noted low in W-I (75.17± 3.715) µg/L during summer season. Thus, all the analyzed essential heavy metals like Cu, Zn and Ni were noted to be in the following trend Zn> Cu> Ni respectively.

The mean concentration of Cd (21.54±2.77) µg/L was recorded maximum during monsoon season and minimum during summer season (12.52 ± 1.71) µg/L. W-III showed high Cd concentration when compared with W-I and W-II. The present findings showed high Cr content in W-III (18.84± 1.045) µg/L during monsoon season and low Cr content in W-I (3.30± 1.310) µg/L during summer season. During the present investigation high Pb content (6.26± 0.752) µg/L was observed in W-III during monsoon season while low Pb (2.51 ± 0.231) µg/L was observed in W-I during monsoon season. Among the non-essential metals Cd and Pb in W-I and W-II were noted to be BDL during summer season. Among the non- essential heavy metals analysed in the selected wetlands waters the Cd> Cr> Pb was noted to be in the following trend.

On comparing essential and non-essential heavy metals essential metals showed maximum concentration in all the selected wetlands throughout the study period. The order of metal concentration in water samples were Zn>Cu>Ni> Pb> Cr>Cd respectively. All the observed heavy metals from water samples were noted to be high during monsoon season followed by winter and summer seasons were presented in (**Table - 2, 3 and 4)**

Table -1
Permissible limit set by national and international organizations.
(For health risk and aesthetic value)

S.No	National and international organization	Heavy metals (µg/L)					
		Cd	Cr	Cu	Ni	Pb	Zn
1.	USEPA,2011	5	100	1300	100	15	5000
2.	WHO, 2008	3	50	2000	70	10	NGL**

NGL**= No Guideline, because it occurs in drinking-water at concentrations well below those at which toxic effects may occur.

Table - 2

Data on the seasonal variations (Monsoon) of heavy metals Cd, Cr, Cu, Ni, Pb and Zn (µg/L) from the selected wetlands during the study period

Study areas	Cd	Cr	Cu	Ni	Pb	Zn
Perur (W1)	7.23±0.154	6.30±1.031	92.13±3.592	29.04±2.106	2.51±0.231	141.71±3.773
Sulur (W2)	10.75±1.352	10.69±±1.047	91.05±3.941	32.99±2.221	3.64±1.514	183.85±4.381
Orathupalayam(W3)	13.54±2.771	18.84±1.045	126.76±4.25	59.54±3.047	6.26±0.752	279.89±3.047

Values were represented as Mean ± SD of three samples in each group. They have 0.05% level of significant

Table-3

Data on the seasonal variations (summer) of heavy metals Cd, Cr, Cu, Ni, Pb and Zn (µg/L) from the selected wetlands during the study period

Study areas	Cd	Cr	Cu	Ni	Pb	Zn
Perur (W1)	BDL	3.30±1.310	42.31±2.541	22.40±1.013	BDL	75.17±3.715
Sulur (W2)	BDL	6.96±1.407	75.50±3.496	25.12±2.514	BDL	83.58±4.417
Orathupalayam(W3)	12.52±1.71	8.84±1.702	92.76±2.452	41.37±3.418	3.27±0.751	97.98±3.494

Values were represented as Mean ± SD of three samples in each group. They have 0.05% level of significant

BDL- Below Detectable Limit

Table -4

Data on the seasonal variations (summer) of heavy metals Cd, Cr, Cu, Ni, Pb and Zn (µg/L) from the selected wetlands during the study period

Study areas	Cd	Cr	Cu	Ni	Pb	Zn
Perur (W1)	5.40±1.243	5.29±1.130	65.71±3.217	25.34±2.742	3.48±1.092	83.21±3.712
Sulur (W2)	9.37±1.426	7.51±1.047	110.30±3.291	29.92±2.113	5.62±1.178	187.92±4.28
Orathupalayam(W3)	11.35±1.621	12.37±1.401	120.49±4.152	50.61±3.104	6.61±1.246	206.78±3.94

Values were represented as Mean ± SD of three samples in each group. They have 0.05% level of significant

Discussion

In the present study water samples from three wetland ecosystem (W-I, W-II, W-III) were collected for the analysis of heavy metal concentration. The occurrence of heavy metals in an aquatic environment is the major menace of pollution control throughout the world. Concentration of certain metals have nutritional concern and their necessary requirement varies among different organisms. (Brama *et al*., 2007) . However, inequity in their proportion and high exposure may cause severe complications (Dong *et al*., 2007; Zhang and Jia , 2007; Soghoian and Sinert, 2008; Zhang *et al*., 2009). The distribution of heavy metal concentration in water samples from the selected wetlands (W-I, W-II, W-III) were in the order of magnitude as Zn > Cu > Ni> Cr> Cd> Pb.

Cadmium is an important parameter in aquatic monitoring due to its toxicity to fishes at higher concentrations and carcinogenic effects in humans even at low concentration (Onojake *et al*., 2017). In the present study, content of cadmium ranged from B.D.L to 13.54 µg/L during summer, monsoon and winter season, respectively. The observed cadmium content was found to be above the drinking water limits of 3 µg/L as prescribed by USEPA (2011) and WHO (2008). Similar results were reported by Onojake *et al*. (2017). The reason for minimum values in summer season and maximum in winter season was attributed to high flow during monsoon season (Sanjoy and Rakesh, 2013; Abdel-Satar *et al*., 2017). In the present study, chromium content ranged from 3.30 to 18.84 µg/L and was found to be below the permissible limits (50 µg/L) as prescribed by USEPA (2011) and WHO (2008) for most of the samples. Many authors observed high Cr content in water samples worldwide. In one such study, Rai (2009) observed Cr content to be as high as 34 µg/L in aquatic ecosystem of industrial region. Lead is a non-essential element which is highly significant in all the heavy metals because of its toxic effect and harmfulness even in a low concentration. High concentration of lead in the body can cause mortality or permanent damage to the central nervous system, the brain, and kidneys (Hanaa *et al*., 2000). Lead content in water samples of the selected wetlands were noted as below the permissible limits of 10 μg/L USEPA (2011) and WHO (2008) at all sampling sites during different seasons. In present study, maximum Pb content of 6.26 μg/L was observed in monsoon season from different sites. Similar, observations were made by various authors who reported high Pb content in surface water bodies such as Kolleru lake wetland (Amaraneni, 2006), Manchar lake (Kazi *et al*., 2009), Douro and Ave river (Couto *et al*., 2018), and Huaihe river (Yang *et al*., 2018)

In present investigation, Cu content was found to be in range of 42.31 – 126.76 μg/L with highest content in winter seasons. In the present investigation concentration of copper was high in Orathupalayam wetland (W3) and low in Sulur wetland (W2). Contamination of drinking water with high level of copper may lead to chronic anemia (Acharya *et al.*, 2008). The Cu concentrations of the present study was below the permissible limit WHO (2008). The nickel concentration of the present study was found to be below the permissible limits. Similar results were reported by Taweel *et al*., (2012) and Fatima and Usmani (2013). In the present investigation maximum Ni concentration was noted in Orathupalayam wetland (W3) while minimum concentration of Ni was noted in Perur wetland (W1). Higher concentration of Ni may act as causative agent for neurotoxic, genotoxic and carcinogenic effects. They may cause health problems like nickel dermatitis etc., Das *et al*., 2008. In the present study, zinc content and ranged from 75.17 to 279.89 μg/L during monsoon season while it was observed to be low in summer season at all the studied sites. The high content in monsoon season might be due to discharge of sewage and surface runoffs from agricultural fields. Wu *et al*. (2008) reported that agricultural runoffs containing zinc sulphates fertilizers were responsible for high zinc in water. Many authors reported Zn content to be below the standard limits in surface water bodies (Muhammad *et al*., 2011; Sanjoy and Rakesh, 2013; Tiwari *et al*., 2015).

From the overall result of the present study it was noticed that maximum concentration of heavy metals were observed during monsoon season while low metal concentration were observed during summer season. The results show that Cd concentration was higher than the permissible limit which set by WHO, 2008 and USEPA, 2011 and other metals (Cu, Ni, Zn, Cr, Pb) were within the permissible limit.

Conclusion

The main aim of the present work was to evaluate the status of drinking water quality in selected wetlands around Coimbatore district with special reference with heavy metal analysis on seasonal variation. The samples were analyzed for six heavy metals including both essential and non-essential (Cu, Ni, Zn & Cd, Cr, Pb,) using standard procedures. All the metal concentrations were high in Orathupalayam wetland (W-III). This is a signal indication of pollution hazards and poor drinking water treatment system in these areas which, in turn, have enhanced the risk on human health.

So the present study recommends the government and other responsible organizations to suggest relevant drinking water treatment techniques which can decrease the current levels of heavy metals, prevent the entry of different kind of waste disposal into wetlands, which is used for domestic purposes, educate the people to have better drinking water practices.

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