Poll Res. 42 (4) : 458-462 (2023)

ISSN 0257–8050
DOI No.: http://doi.org/10.53550/PR.2023.v42i04.008

ANALYSIS OF HEAVY METALS IN EFFLUENT AND SOIL FROM RANIPET DISTRICT, INDIA

MANGAYARKARASI A.[1] AND AKILAN M.[2*]

[1] P.G. & Research Department of Zoology, Arignar Anna Govt. Arts College (W) Walajapet, Ranipet, India
*[*2]P.G & Research Department of Zoology, Voorhees College, Officers line Vellore 362 001, T.N., India*

(Received 14 April, 2023; Accepted 16 July, 2023)

ABSTRACT

The present study was focussed about the analysis of selected heavy metal in the five sampling stations from the Ranipet district. Effluent and soil (surface:<30cm and deep: >30cm) samples are collected from all the stations (TCC limited, Emerald Nagar, Puliyanganu lake, Puliyanganu and Karai SRP nagar). By acid digestion method, the heavy metal composition of the samples were analysed. Among the five stations, effluent chromium levels found high in Puliyanganu (S4) whereas high incidence of surface and deep soil Cr levels observed as 990.28±121.3 and 1685.47±221.6mg/Kg respectively.Our results evidenced that the heavy metal levels in the tested sampling stations were above the permissible limits.

KEY WORDS : Heavy metals, Ranipet, Effluent, Surface soil

INTRODUCTION

Many Asian countries are rapidly increasing their industrial sector for the enrichment of urban society which eventually develop a serious challenge to the environmental sustainability (Chhonkar *et al*., 200b). In this industrial era, the aquatic ecosystems (fresh and marine) are considered as the ultimate sink of the various domestic and industrial effluents. Release of heavy metals, charged ionic particles and pathogens into the water system pose a serious threat to the life forms in both aquatic and terrestrial (Yadav *et al*., 2005).

Figure 1 showed the summary of the heavy metal

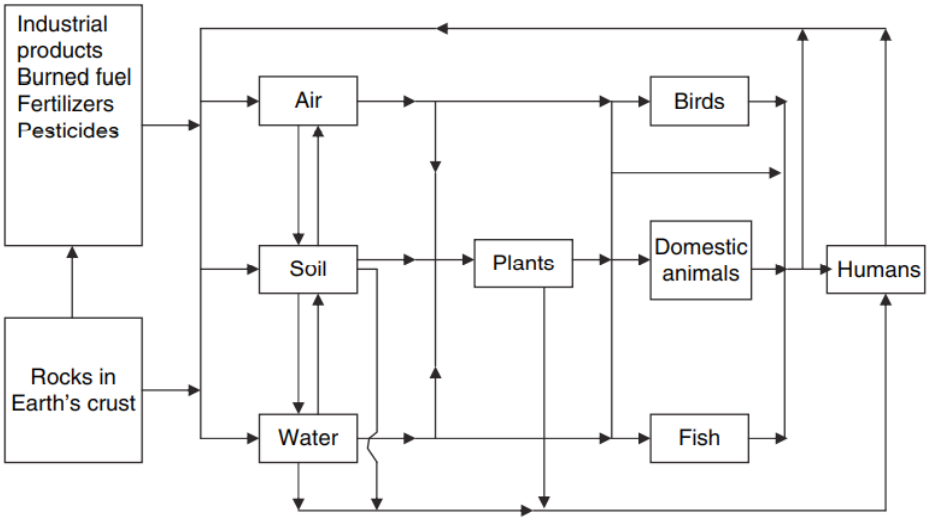


Fig. 1. Overall summary of the heavy metal augmentation from abiotic to biotic agents

augmentation from source to sink through abiotic and biotic factors (Purakayastha and Chhonka, 2010). Heavy metals are the common source of contamination from the industrial effluents. Either metals or metalloids with 6Mg/m^{3}density are classified as heavy metals which are ultimately become toxic to flora and fauna (Alloway, 1990). Chromium (Cr), Lead (Pb) and Iron (Fe) metals small doses also induces various health illness such as genetical and neurological disturbances, embryo growth impairment, severe anaemia and demineralization (Gupta and Gupta, 1998; Satish and Amit, 2015).

Tannery effluents are rich in chromium ions which are the potential hazardous source to the environment. Due to the increased release of heavy metal (Cr, Fe) rich effluents resulted the accumulation of these metals into the terrestrial environment particularly on the river banks, irrigation fields (Asfaw, 2014). The main objective of this study is to collect the effluent and soil (surface, deep) from the selected sampling stations - TCC limited, Emerald Nagar, Puliyanganu lake, Puliyanganu and Karai SRP nagar(S1-S5) from the industrial areas of Ranipet district. The heavy metal (Cr, Pd and Fe) composition of effluent and soil (surface and deep) samples are analysed by acid digestion method.

MATERIALS AND METHODS

Study area

In North East Vellore, the Ranipet town is located at 79.20°E and 12.56°N (long. & lat.). In Ranipet town, Karai and Puliankanu areas are the high population zone with many leather and chemical industrial sectors. Five different sampling stations (Fig. 1) such as S1-TCC limited (Lat.12.952, Long.79.310), S2-Emerald Nagar (Lat.12.951, Long. 79.312), S3-Puliyanganu lake (Lat. 12.943, Long. 79.308), S4-Puliyanganu (Lat. 12.935, Long. 79.306) and S5-Karai SRP nagar (Lat.12.941, Long. 79.314) stations from Ranipet district were selected for this study.

Sample collection

In the sampling stations, effluents and soil samples were collected during the pre-monsoon season (during summer season). Clean and sterile sample containers (20 ml) were used for the effluent collection. For the soil samples (Sparks, 1996), two methods were followed. For the surface soil collection, in a clean and sterile sample bags with a clean spatula, 5gm of soil from the depth of less than 30cm (<30cm) and above 30cm (>30cm). Effluent and soil samples were transported to the laboratory for heavy metal analysis.

Heavy metal analysis

For acid digestion method, modified Hossner mixture was prepared by three chemicals – sulphuric acid, $HClO_4$ and HNO_3 (3:2 v/v). The effluent water samples were mixed the hossner solution and the residues were dissolved completed and filtrate was filtered through Whatmann filter paper (no.42) (Sinha *et al*. 2001). The filtrate was subjected to atomic absorption spectrophotometer and their heavy metal composition were analysed. Soil samples were air dried in the laboratory and sieved with mesh (2mm) to remove the dirt. Soil samples were repeatedly washed with deionized water the soil samples and again air dried (Adugnaw *et al*., 2021). Soil samples were also subjected to heavy metal analysis.

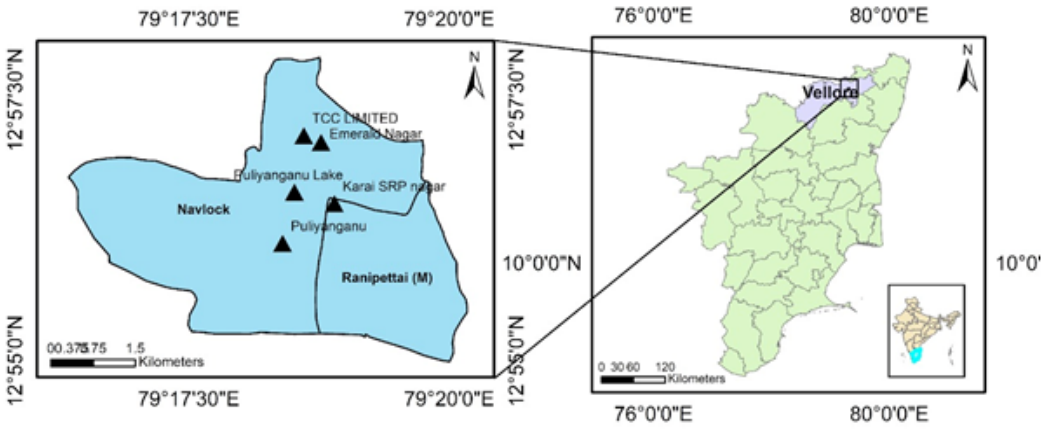


Fig. 1. GPS location of the sampling stations in Ranipet district

Statistical analysis

The collected data are evaluated and expressed as mean±SD. Results are expressed as cluster bar diagram (with exponent power potential axis)by using SPSS software (17.0).

RESULTS AND DISCUSSION

Table 1 showed the mean±SD of the summary results of the heavy metals in effluents, surface soil and deep soil collected from five different sampling stations in Ranipet district. High incidence of heavy metal pollution (mostly Cr and Fe) due to the tannery industrial effluent into the aquatic system than compared to the unpolluted zone were evidenced by various studies, Tariq *et al.* (2005), Sinha *et al.* (2006), Gupta and Sinha (2006).

In TCC limited (S1) sampling station, the effluent water heavy metals were observed as 2344±97.34, 38.9±3.4 and 5389±134.3 mg/l for Cr, Pb and respectively. Surface and deep soil Cr heavy metals also observed as 190.28±89.8 and 225.47±76.7 mg/Kg, 16.41±4.5 and 37.86±5.6 mg/Kg for Pb and $4.3\pm0.9\times10^3$ and$5.3\pm0.8\times10^3$ mg/Kg for Fe metal (Figure 2 and 3).

In Emerald Nagar (S2) sampling station, 3906±85.6 mg/l of Cr, 44.5±6.7 mg/l of Pb and

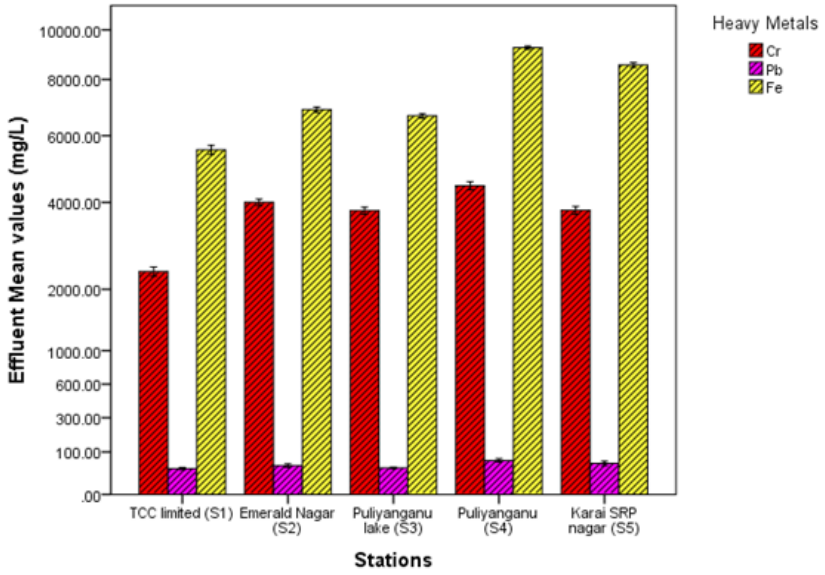


Fig. 2. Heavy metal analysis in sampling station industrial effluent

Table 1. Heavy metals analysis in effluent water and soil (surface and deep) collected from the industrial sector of Ranipet district.

Stations	Heavy metals	Effluent water (mg/L)	Soil (mg/Kg)	
			<30cm depth	>30cm depth
TCC limited (S1)	Cr	2344±97.34	190.28±89.8	225.47±76.7
	Pb	38.9±3.4	16.41±4.5	37.86±5.6
	Fe	5389±134.3	$4.3\pm0.9\times10^3$	$5.3\pm0.8\times10^3$
Emerald Nagar (S2)	Cr	3906±85.6	594.20±98.5	788.13±109.3
	Pb	44.5±6.7	11.32±2.06	28.94±4.3
	Fe	6789±189.3	$5.9\pm1.2\times10^3$	$6.6\pm1.4\times10^3$
Puliyanganu lake (S3)	Cr	3678±234.5	390.28±78.6	537.17±76.8
	Pb	41.2±9.8	16.74±3.4	27.15±4.1
	Fe	6583±867.4	$4.8\pm0.7\times10^3$	$5.5\pm0.9\times10^3$
Puliyanganu(S4)	Cr	4344±564.2	990.28±121.3	1685.47±221.6
	Pb	61.2±8.9	21.49±2.7	57.06±7.9
	Fe	9197±789.9	$2.4\pm0.8\times10^3$	$4.1\pm1.1\times10^3$
Karai SRP nagar(S5)	Cr	3684±245.6	720.08±119.4	965.73±145.6
	Pb	49.9±8.7	36.24±12.3	65.16±9.9
	Fe	8457±675.5	$5.9\pm0.7\times10^3$	$7.8\pm1.4\times10^3$

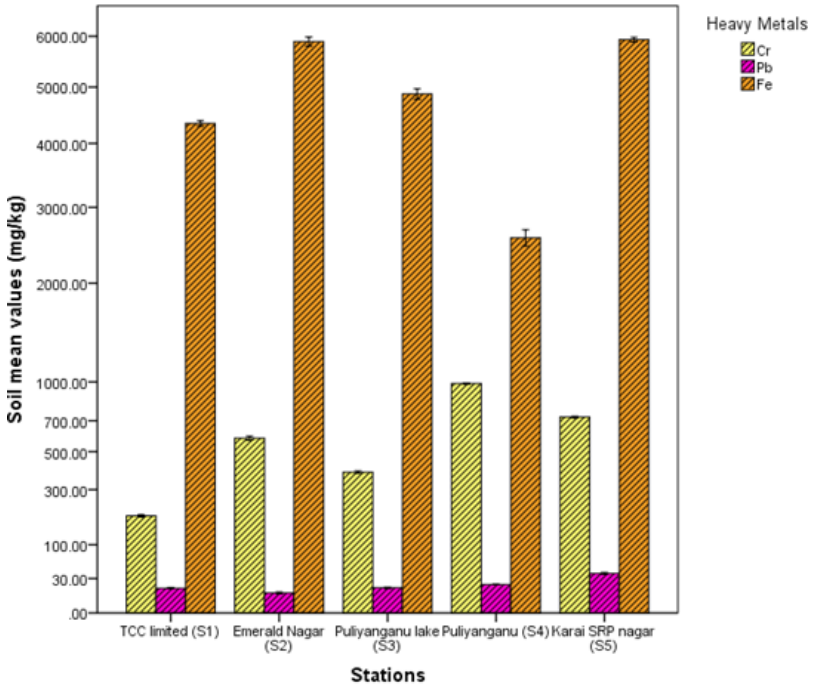
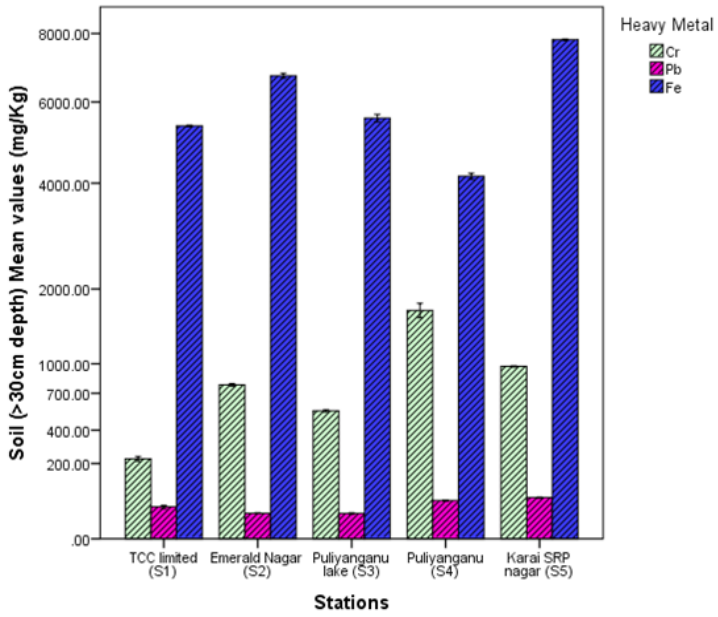


Fig. 3. Heavy metal analysis in surface and deep soil from sampling stations

6789±189.3 mg/l of Fe metals whereas the surface soil (<30cm) Cr, Pb and Fe levels were found as 594.20±98.5, 11.32±2.06 and 5.9±1.2×10^3 mg/Kg respectively. 788.13±109.3, 28.94±4.3 and 6.6±1.4×10^3 mg/Kg concentrations of Cr, Pb and Fe were observed. In Puliyanganu lake (S3) and Puliyanganu (S4) stations, the Cr levels was observed as 3678±234.5 mg/l, 390.28±78.6 mg/Kg, 537.17±76.8 mg/Kg and 4344±564.2 mg/l, 990.28±121.3 mg/Kg, 1685.47±221.6 mg/Kg in effluents, surface soil and deep soil sample. Lead (Pb) levels were observed as 41.2±9.8 mg/l, 16.74±3.4mg/Kg, 27.15±4.1mg/Kg and 61.2±8.9 mg/l, 21.49±2.7 mg/Kg, 57.06±7.9mg/Kg for S3 and S4 sites respectively. Iron (Fe) levels were observed as 6583±867.4 mg/l, 4.8±0.7×10^3 mg/Kg, 5.5±0.9×10^3 mg/Kg and 9197±789.9 mg/l, 2.4±0.8×10^3 mg/Kg, 4.1±1.1×10^3 mg/Kg for S3 and S4 sites respectively.

In Karai SRP nagar (S5) sampling station, effluent Cr, Pb and Fe levels were found as 3684±245.6 mg/



l, 49.9±8.7 mg/ l and 8457±675.5 mg/l respectively. Surface and deep soil Cr levels found as 720.08±119.4 and 965.73±145.6 mg/Kg whereas Pb and Fe levels found as 36.24±12.3 mg/Kg, 65.16±9.9 mg/Kg and 5.9±0.7×10^3 mg/Kg,7.8±1.4×10^3 mg/Kg respectively. Similar to our results were evidenced by Abdelazeem *et al*. (2015) from Riyah (Saudi Arabia) dumping site sludge as 2086, 29.7 and 5341mg/kg for Cr, Pb and Fe metals respectively. Krishna and Govil (2008) reported the high concentrations of chromium content in the soil sample collected from the tannery effluent treatment plants in Chennai (South India). The permissible limit of the chromium, lead and iron in the sludge were reported as 750-1200 mg/Kg, 750-1250 mg/Kg and varied by CEC (1986). According to TPCB (2010), the Cr, Pb and Fe levels in the sludge collected from the Ranipet district was measured as 190 mg/Kg, 1.5 mg/Kg and 34545 mg/Kg.

CONCLUSION

Heavy metals like Cr and Pbcause serious deleterious effects to both plant (irrigation) and animals (genetical and neurological disturbances). Analysis of heavy metals from the sampling stations evidenced the percentage of contamination were high. The study results evidenced the values are above the permissible limit. It is essential to perform immediate remedial measures to the contaminated zones.

ACKNOWLEDGEMENT

The author group are expressed their heartfelt thanks to the Founder, Principal, Head of the Department for their constant support and encouragement during this study.

REFERENCES

Abdelazeem, Sh. S., Adel, R.A.U., Hassan, A.A., Mohammad, I.A.W. and Abdulrasoul, A. 2015. Environmental assessment of tannery wastes in relation to dumpsite soil: a case study from Riyadh, Saudi Arabia. *Arab J Geosci*. DOI 10.1007/s12517-015-1956-7

Adugnaw, M.G., Fekadu, F. F., Esayas, A.T. and Embialle, M.B. 2021. Chromium Laden Soil, Water, and Vegetables nearby Tanning Industries: Speciation and Spatial Distribution. *Journal of Chemistry*. Volume 2021, Article ID 5531349, 10 pages.

Alloway, B.J. 1990. Heavy metals in soils. Blackie, Glasgow.

Asfaw, A. 2014. Heavy metals concentration in tannery effluents associated surface water and soil at Ejersa area of East Shoa, Ethiopia. *Herald J Geogr Reg Plan.* 3: 124-130

CEC (Council of the European Communities). Council directive of 12th June 1986 on the protection of environment and in particular of the soil, when sewage sludge is used in agriculture (86/278/eec) off. *J Exp Biol*. 181: 6-12.

Chhonkar, P.K., Datta, S.P., Joshi, S.C. and Pathak, H. 2000. Impact of industrial effluents on soil health and agriculture II.Tannery and textile industrial effluents. *J Scientific Industrial Res*. 59: 446-454.

Gupta, A.K. and Sinha, S. 2006. Chromium levels in vegetables and grains grown on tannery effluent irrigated area of Jajmau, Kanpur, India: influence on dietary intake. *Bull Environ ContamToxicol*. 77: 658-664.

Gupta, C. and Gupta, S. 1998. Trace element toxicity relationships to crop production and livestock and human health: implications for management. *Comm. Soil Sci. Plant Anal.* 29: 1491-1522.

Krishna, A.K. and Govil, P.K. 2008. Assessment of heavy metal contamination in soils around Manali industrial area, Chennai, *Southern India. Environ Geol.* 54: 1465-1472.

Purakayastha, T.J. and Chhonkar, P.K. 2010. Phytoremediation of Heavy Metal Contaminated Soils. I. Sherameti and A. Varma (eds.), *Soil Heavy Metals, Soil. Biology*. 19.

Satish, A.B. and Amit, S.S. 2015. Chromium: As an Environmental Pollutant. *Int. J. Curr. Microbiol. App. Sci.* 4(4): 732-746.

Sinha, S., Gupta, A.K., Bhatt, K., Pandey, K., Rai, U.N. and Singh, K.P. 2006. Distribution of metals in the edible plants grown at Jajmau, Kanpur (India) receiving treated tannery wastewater: relation with physico-chemical properties of the soil. *Environ Monit Assess*. 115 : 1-22

Sinha, S., Saxena, R., Singh, S. 2001.Comparative Studies on Accumulation of Cr from Metal Solution and Tannery Effluent Under Repeated Metal Exposure by Aquatic Plants: Its Toxic Effects. *Environmental Monitoring and Assessment*. 80: 17-31.

Sparks, D.L. 1996. *Methods of Soil Analysis*. Soil Society of American, Madison.

Tariq, R.S., Shah, M.H., Shaheen, N., Khalique, A., Manzoor, S. and Jaffar, M. 2005. Multivariate analysis of selected metals in tannery effluents and related soil. *J Hazard Mater*. 122:17-22.

TPCB (Tamilnadu Pollution Control Board),2010. Revised action plan for critically polluted area, Ranipet.

Yadav, S., Shukla, O.P. and Rai, U.N. 2005. Chromium pollution and bioremediation. *Enviro News News Lett Int Soc Env Bot.* II:1