



Received on 16 August 2019; received in revised form, 08 January 2020; accepted, 18 April 2020; published 01 July 2020

Cr AND Pb CONTAMINATION IN AGRICULTURAL SOIL IN TWO DIFFERENT SEASONS AND THREE DEPTH OF THE SOIL LAYER SAMPLES NEARBY TANNERY WASTE DISPOSAL ZONES AT RANIPET, VELLORE DISTRICT IN THE SOUTHERN INDIA

A. Kistan^{*1} and V. Kanchana²

Department of Chemistry¹, Panimalar Institute of Technology, Chennai - 600123, Tamil Nadu, India.

Department of Chemistry², Sree Sastha Institute of Engineering and Technology, Chennai - 600123, Tamil Nadu, India.

Keywords:

Heavy metal, Agriculture land, Soil layer, Different seasons, Chromium, Lead, Tannery effluent, Vellore District

Correspondence to Author:

A. Kistan

Assistant Professor,
Department of Chemistry,
Sree Sastha Institute of Engineering
and Technology, Chennai - 600123,
Tamil Nadu, India.

E-mail: vishmikrish@gmail.com

ABSTRACT: This paper investigates the determination of trace metals named Chromium and Lead set down in the soil as well as in the groundwater due to the tanning industries area of Ranipet town, Vellore city. The tanneries discharge untreated tannery effluents, which get mixed with the soil, water of the Palar river, and underground in this area. The determination of metals was performed for the soil that was collected from the agricultural land adjacent to the Palar River, which bears untreated tannery effluents at pre-monsoon and post-monsoon seasons. The soil samples were collected from three different layers of different depths in these agricultural lands. The first layer is the superficial layer (0 - 10 cm); the second layer is 30 - 40 cm, and the other is 60 - 70 cm below from the surface level. The soil is affected by the untreated effluents through the deposition of heavy metals. The metals might be deposited into the plants and vegetables grown on that agricultural soil, which disturb human health. An extreme amount of chromium was found in all soil samples, especially in the case of superficial layer (0 - 10) part of the soil in pre-monsoon. Chromium and Lead were analyzed by the Atomic adsorption spectroscopy technique (AAS). These metals contamination in the soil is answerable for the support of harmfulness in farming crops and underground water.

INTRODUCTION: Tanneries are the most useful foreign money sector in India. More than 600 tanneries are located in the Vellore district, and among them, 150 are situated in Ranipet, Vellore district close to the Palar River, covered apart of 48 hectare and the remaining tanneries are situated in further Towns of Vellore district. Vellore district tanneries are posing a heavy risk for our surroundings.

For the tanning process, lots of chemical substances are used as dyes, Sodium Chloride salt, Calcium hydroxide, Chromium salt; inorganic acids are widely handled to complete the process. During the tanning process, only 50-60% of raw skin takes the functional chemical and remaining discharged as wastes. Almost many tanneries of Vellore district do not have sewage management conveniences¹⁻³.

Tanneries are disposing of untreated wastes and sewage straightly to open drainage, which will be lastly connecting in the Palar River. The focus of our study was the current status of abundant metals (Cr, Pb, Zn, Cd, & Cu) in and around tannery discharge affected land and compared the results with the contamination of abundant heavy metals in

<p>QUICK RESPONSE CODE</p> 	<p>DOI: 10.13040/IJPSR.0975-8232.11(7).3469-73</p> <hr/> <p>This article can be accessed online on www.ijpsr.com</p> <hr/> <p>DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.11(7).3469-73</p>
---	---

uncontaminated land such as agricultural and residential areas of Ranipet, Vellore district, Tamil Nadu. From this research, it has been explained that heavy metals contagion in soil has now a day's become a major concern. In a growing nation of India, the condition is not better because of the deficiency of scientific improvement. It is clearly evident that tanneries locality soil samples of Ranipet, Vellore. Now a day's contamination of land is becoming a most important responsibility⁴. In the growing country of India, the condition is most horrible because of inadequate scientific improvement. In this revise, it is proved that the soil samples in the tannery locality of Ranipet, Vellore district is exceedingly contaminated with Cr not with other Pb. This is as a result of being acquired an enormous quantity of raw tanning process wastes coming from the near Tanneries day after day^{5, 6}. The Chromium and Cadmium concentration in the agriculture soil varies in relation to different anthropogenic activities, the intrusion of polluted domestic sewage water, and seepage of tannery pollutants⁷. The pre-monsoon values indicate that most of the soil samples belong to the salted type and it has been found that much of dilution has occurred during the post-monsoon where the Cr concentration was significantly lowered. Moreover, the Cr and Pb values of the soil samples are slightly higher than the permissible limit for both the pre and post-monsoon samples⁸.

The result of the trace metal concentrations shows that Cr and Pb concentrations are found to be very slightly higher than the prescribed limit in a few sample sites. The major factors which explain the various loadings are precipitation and chemical weathering and anthropogenic. The results show that the groundwater in the study area may affect by the tannery activities, and in the downstream, both anthropogenic and chemical weathering factors are found to be significant⁹. The present state of the quality of the Ranipet industrial area is

of great concern, and the higher concentration of trace metals may entail various health hazards. A considerable decrease in the concentration of Cr and Pb in the post-monsoon soil samples indicates that the dilution factor predominates over the leaching factor¹⁰. If the leachate migration from chromium and other solid waste from tannery dump not intercepted at this stage it would further contaminate the groundwater reservoir posing a major threat to the complete agriculture activities of area¹¹.

This study reported that these two heavy metals (Cr & Pb) concentration is significantly higher in the soil at the site of the tannery locality than in the normal agricultural and residential areas and also these two metals strength was found to be not very much significant changes in the soil at the site of the normal agricultural and residential areas. A considerable quantity of Pb has also been found in the soil of this area, which was not exceedingly contaminated but very slightly contaminated in only a few sample points in this study locality¹². This kind of metals might be accumulated in soil and adsorbed by vegetables and fruits through the route of plants and some other crop grown-up in this study area that eventually gets into humans and animals through the tropical food cycle¹³. So, governments need to take instantaneous measures for these problems to control this kind of infectivity by heavy metal contamination¹⁴.

MATERIALS AND METHODOLOGY:

Sampling Period: In the month of March 2018, the soil samples were collected from the sampling sites with the help of a Steel Trenching hoe and transferred to pre-cleaned plastic bottles. The samples were collected from two dissimilar layers of different depths at all points. The first layer is the shallow layer (0 - 10 cm), and the other is 30 - 40 cm below from the surface level by measuring with 100 cm wood ruler.



FIG. 1: COLLECTION AND PREPARATION OF SOIL SAMPLES FOR ANALYSIS

After gathering the soil samples were washed, weighed, and dried in an oven at 110 °C until becoming constant weight. After cooling in desiccators with fused Calcium chloride, all the samples were crushed and thoroughly homogenized by manually with the help of a stone soil grinder. The crushed soil samples were lastly stored in cleaned dry closed glass bottles and well-maintained in desiccators for further analysis.

Digestion of Soil Sample: For the quantitative analysis of Cr, Pb, Cd, and Zn soil samples were digested following ISO: 11466 thermal heating methods. According to this method, the first 5 go fetch crushed soil samples were weighed and taken into pre-cleaned 100 ml glass beakers. Then, the weighed samples were humidified with 2 ml of deionized water. After that 24 ml, of HCl and 8 ml of HNO₃ were poured drop by drop, and then 18 ml of dilute HNO₃ (0.5M) was poured to every beaker and the samples were permitted to a position at lab temperature (27-30 °C).

Every mixture was then refluxed on heating not a plate for 2 h and was filtered through filter paper (Whatman no. 42) after cooling and kept at room temperature for further analysis.

Total Heavy Metals Concentration Measurement: The digested soil substances used for determination of Chromium and Lead by using Flame atomic absorption spectrometer (FAAS - Model Varian Spectra A240), (Sample volume - 10 mL/min. Burner - Air/Acetylene, N₂O/Acetylene burner/Gases hallow cathode - Acetylene and nitrous oxide) at Technology Business incubator Lab, Department of Science and Technology, VIT-university, Vellore, Tamil Nadu. Cr (λ_{\max} : 357.9 nm), Pb (λ_{\max} : 283.3 nm). The instrument is having a minimum detection limit of 0.10 mg/L for Cr, 0.20 mg/L for Pb in the flame method. Substances were aspirated over Nebulizer, and absorbance was measured with a colorless solution (Deionized water) as reference.

RESULTS AND DISCUSSION:

TABLE 1: HEAVY METAL ANALYSIS OF TANNERY LOCALITY SOIL SAMPLES NEAR DUMPING SITES OF PALAR RIVER

Sampling places	Locations	Soil Samples	Depth of layers from superficial level (cm)	Pre-monsoon		Post monsoons	
				Cr (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Pb (mg/kg)
SP-1	Near Palar river basin agricultural land	SS-1	0 – 20	24.28	52.58	21.39	48.34
		SS-2	30 – 50	64.64	76.61	59.13	72.37
SP -2		SS-3	60 – 80	65.23	82.32	61.63	78.08
		SS-4	0 – 20	48.26	64.23	38.73	49.99
SP -3		SS-5	30 – 50	56.29	60.42	50.86	52.18
		SS-6	60 – 80	60.22	68.42	55.63	64.18
SP -4		SS-7	0 – 20	59.68	42.29	56.23	34.05
		SS-8	30 – 50	68.7	56.5	62.25	52.26
SP -5		SS-9	60 – 80	75.42	88.65	71.97	74.41
		SS-10	0 – 20	32.11	38.73	28.66	34.49
SP -6	SS-11	30 – 50	33.33	20.37	29.88	15.13	
	SS-12	60 – 80	58.26	78.56	51.81	71.32	
SP -7	SS-13	0 – 20	70.84	28.45	67.39	24.21	
	SS-14	30 – 50	60.43	50.06	56.98	43.82	
SP -8	SS-15	60 – 80	72.24	98.54	64.79	91.35	
	SS-16	0 – 20	26.61	15.68	23.16	11.44	
SP -9	SS-17	30 – 50	38.26	35.29	35.81	31.05	
	SS-18	60 – 80	52.48	82.45	49.03	78.21	
SP -10	SS-19	0 – 20	10.47	46.08	5.02	41.84	
	SS-20	30 – 50	59.45	75.28	56.23	65.04	
SP -10	SS-21	60 – 80	63.25	102.58	52.85	98.34	
	SS-22	0 – 20	15.88	65.24	12.43	61.52	
SP -9	SS-23	30 – 50	34.56	69.44	32.21	65.23	
	SS-24	60 – 80	39.46	98.75	35.08	94.51	
SP -9	SS-25	0 – 20	28.46	78.49	25.01	74.25	
	SS-26	30 – 50	56.48	102.78	50.03	98.54	
SP -9	SS-27	60 – 80	59.62	110.26	54.17	103.02	
	SS-28	0 – 20	35.57	42.15	32.12	31.94	
SP -10	SS-29	30 – 50	40.02	49.06	36.57	43.82	
	SS-30	60 – 80	59.13	67.54	53.68	53.3	

Minimum	10.47	15.68	5.02	11.44
Maximum	75.42	110.26	71.97	103.02
Mean	48.99	64.93	44.36	58.61
SD	17.65	25.19	17.06	26.45
Maximum allowable limit recommended by EC (1986)13	50	300	50	300

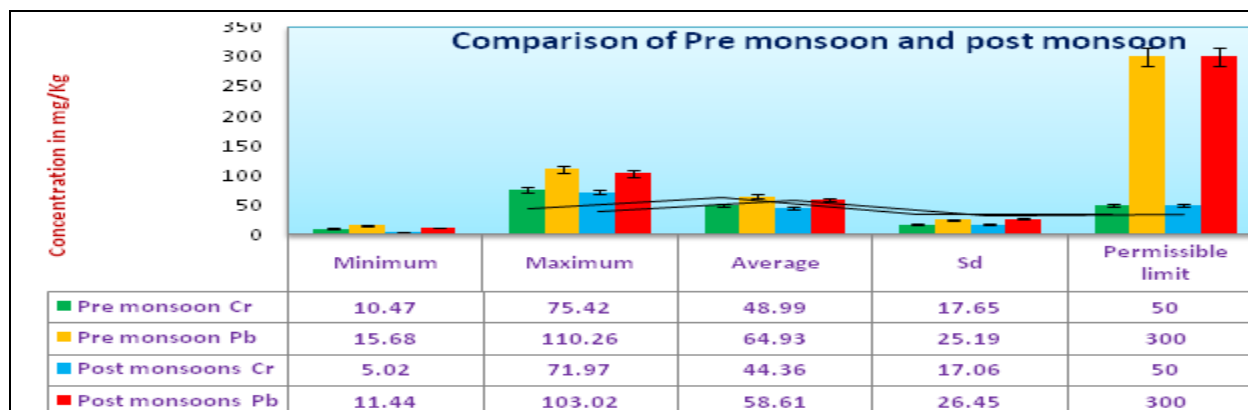


FIG. 2: COMPARISON OF Cr AND Pb CONTAMINATION IN SOIL SAMPLES AT BOTH SEASONS

Lead (Pb): In the present investigation, the lead concentration ranges from 15.68 to 110.26 mg/kg in pre-monsoon and 11.44-103.02 mg/kg in post-monsoon. All values of lead are showed not higher than the Maximum allowable limit recommended by EC (1986) ¹³ **Table 1** and **Fig. 2**. The maximum permissible concentration of lead in sediment soil samples is 300 mg/kg. Lead content present in these collected soil samples may be the result of entry from tannery effluents, other industrial effluents, household sewages containing phosphate fertilizers, and human and animal excreta ¹⁵. In case if high concentrations of lead in the body can cause death or permanent damage to the central nervous system and brain, which the effects can be in memory. Other effects are high blood pressure, hearing problems, headaches, slowed growth, reproductive problems in men and women, digestive problems, muscle and joint pain ^{16, 17}.

Chromium (Cr): In the present investigation, the Chromium concentration ranges from 10.47 to 75.42 mg/kg in pre-monsoon and 5.02-71.97 mg/kg in post-monsoon. All values of lead are showed higher than the maximum allowable limit recommended by EC (1986) ¹³ **Table 1** and **Fig. 2**. Chromium is an essential micronutrient for animals and plants and is considered as a biological and pollution significant element ^{17, 19}. The values of chromium in the soil samples are recorded exceeded in some samples points maximum allowable limit recommended by EC (1986) ¹³ **Table 1**. The maximum permissible concentration

of lead in sediment soil samples is 50 mg/kg. This may be due to the various anthropogenic activities. Almost the values are more than the permissible limit of 30 mg/kg, but samples exceed in post-monsoon and pre-monsoon seasons. The high content of chromium may be due to various anthropogenic activities, industrial effluents, tanneries, old plumbing and household sewages ²⁰.

CONCLUSION: It has been found that the average concentration Chromium and Lead in the study areas in Pre-monsoon 48.99 mg/kg and 44.36 mg/kg, respectively. Similarly, it has been found that the average concentration Chromium and Lead in the study areas in Post monsoon 64.93 mg/kg and 58.61 mg/kg, respectively, **Table 1** and **Fig. 2**. It is clear that Pre-monsoon heavy metal contamination was higher than Pre-monsoon season. Analysis of trace heavy metals of Pb and Cr in these soil samples were done for Pb and Cr. **Table 1** and **Fig. 2**.

From the above results, superficial layers (0 - 20 cm) of soil samples less contaminated than deep layers (30 - 50 cm & 60 = 80 cm). Contamination of soil portion increase with an increase in depth of the soil layers this is due to percolation tannery effluent into earth **Table 1** and **Fig. 2**. It is also found that in both the residential and Palar river basin, agricultural land contamination was almost equal. Most of the soil sample locations from these study areas not suitable for agriculture use, and it's unlikely to pose a major health risk to plant growth

and crop yields. From both Palar River and residential areas, some of the soil samples can safely be used for agriculture purposes. This information must be shared with people of the area and suggested to improve the soil fertility. The data may also be shared with public health.

Remedy: In order to overcome the above problems, heavy metal can be suppressed from effluents and waste of tanneries and other industries, some low-cost adsorbent can be recommended such as coconut shell carbon, rice husk carbon, fly-ash, charcoal, *etc.* before discharging effluent into surface water body this adsorbent should be used which will be very useful to suppress metal contamination.

ACKNOWLEDGEMENT: One of the authors is acknowledged for Instrumental facilities.

CONFLICTS OF INTEREST: The authors declare that there is no conflict of interest regarding the publication of this article.

REFERENCES:

1. Kumar N and Sinha DK: Seasonal variation of iron in underground drinking water sources in and around Moradabad City, Uttar Pradesh, India. *International Journal of Applied Engineering Research* 2018; 13(13): 11062-68.
2. Singh M, Singh A, Kumar S, Srivastara N, Singh, S and Chowdhary AK: Arsenic mobility in fluvial environment of the Ganga plain, Northern India. *Environmental Earth Science* 2010; 59(8): 1703-15.
3. Alsaffar MS, Jaafar, Suhaimi M, Kabir and Ahmad N: Evaluation of heavy metals in Surface water of major rivers in Penang, Malaysia. *International Journal of Environmental Science* 2016; 6(5): 657-69.
4. Jha AK and Kumar U: Studies on removal of heavy metals by *Cymbopogon flexuosus*. *International J of Agriculture, Environment and Biotechnology* 2017; 10(1): 89.
5. Sankaran S, Rangarajan R, Kumar KK, Rao SS and Humbarde SV: Geophysical and tracer studies to detect subsurface chromium contamination and suitable site for waste disposal in Ranipet, Vellore district, Tamil Nadu, India. *Environmental Earth Sciences* 2010; 60(4): 757-64.
6. Kistan A, Anandana VA and Ansari AT: Investigation on chemical contamination in bore well, dug well and Palar river water near Tannery Locality of Vellore District, India. *International Journal for Research in Applied Science & Engineering Technology* 2017; 5.
7. Samundeeswari S and Lakshmi S: Biochemical Parameters of two halophytes (*Suaeda maritima* (L) Dumort, and *Sesuvium portulacastrum* (L) to the application of Tannery effluents. *International Journal of Current Research* 2018; 10(2): 65385-90.
8. Aggarwal T, Singh KN and Gupta AK: Impact of sewage containing domestic wastes and heavy metals on the chemistry of Varuna river water, *Poll. Res* 2000; 19(3): 491-94.
9. Kotteswaran M, Sundaresan S, Preethy R and Senthilkumar B: Analysis of some Heavy Metals in Water, Soil and Fish from Pulliyankannu Lake at Ranipet, Vellore Dist., Tamil Nadu, India. *International Journal of Pharmaceutical and Biological Archiver* 2015; 6(2): 32-36.
10. Kumar PJS and James EJ: Assessing the impact of leather industries on groundwater quality of Vellore District in South India using a geochemical mixing model. *Environmental Claims Journal* 2019; 1-14.
11. Ramesh K and Thirumangai V: Impacts of tanneries on quality of groundwater in Pallavaram, Chennai Metropolitan City. *Int J Eng Res Appl* 2014; 4: 63-70.
12. Begum A, Ramaiah M, Harikrishna, Khan I and Veena K: Heavy metal pollution and chemical profile of Cauvery river water. *E J of Chem* 2009; 6(1): 47-52.
13. Sundar K and Chandrasekaran N: Seasonal variations in the chromium concentration and chromium resistant bacterial populations in Vellore district. *Res J Appl Sci Eng Technol* 2010; 2(4): 378-80.
14. Kistan A, Selvakumari S, Sangeetha P, Kanchana V and Ansari AT: Present-day position of heavy metal adulteration in top soil Affected by Tannery actions, Vaniyambadi, Vellore district. *International Journal of Current Research in Life Sciences* 2018; 7(01): 843-49.
15. Ahada CP and Suthar S: Groundwater nitrate contamination and associated human health risk assessment in southern districts of Punjab, India. *Environmental Science and Pollution Research* 2018; 25(25): 25336-47.
16. Goje LJ, Maigari FU and Jadeed MP: Determination of the level of some heavy metals and trace elements in river Gongola of Adamawa State, Nigeria. *Int J of Innovative Science, Engineering & Technology* 2017; 4(1): 163-69.
17. Mahmood A and Malik RN: Human health risk assessment of heavy metals *via* consumption of contaminated vegetables collected from different irrigation sources in Lahore, Pakistan. *Arabian J of Chem* 2014; 7(1): 91-99.
18. Khapre AS, Lakshminathan C and Sunikumar: Physico chemical analysis and isolation of microbes from ground water nearby land fill site: A case study. *Indian Journal of Experimental Biology* 2018; 56(7): 526-30.
19. Lokeshwari H and Chandrappa GT: Heavy Metals Content in Water, Water Hyacinth and Sediments of Labagh Tank, Bangalore (India). *Journal of environmental science & engineering* 2006; 48(3): 183-88.
20. Gowd SS, Reddy MR and Govil PK: Assessment of heavy metal contamination in soils at Jajmau (Kanpur) and Unnao industrial areas of the Ganga Plain, Uttar Pradesh, India. *J of Hazardous Materials* 2010; 174(1-3), 113-121.

How to cite this article:

Kistan A and Kanchana V: Cr and Pb contamination in agricultural soil in two different seasons and three depth of the soil layer samples nearby tannery waste disposal zones at Ranipet, Vellore district in the Southern India. *Int J Pharm Sci & Res* 2020; 11(7): 3469-73. doi: 10.13040/IJPSR.0975-8232.11(7).3469-73.