Research Journal of Applied Sciences, Engineering and Technology 2(4): 378-380, 2010
ISSN: 2040-7467

Submitted Date: April 09, 2010 Accepted Date: May 01, 2010 Published Date: July 10, 2010

Seasonal Variations in the Chromium Concentration and Chromium Resistant Bacterial Populations in Vellore District

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Abstract: Tanneries in Ambur, Vaniambadi, Pernambut, Ranipet and Walajapet are clustered on the banks of the Palar River. This is the primary source of drinking water for the residents of Vellore district. Reports have shown that the soil and ground water of these places are heavily contaminated with salts and heavy metals especially Chromium. The water quality parameters in the area are found to be above the WHO permissible limits (0.05 mg/L). Based on the basic survey on tanneries and its pollution in the Vellore District, our studies focused on bio-remediation of tannery effluents, which is the main source of contamination. As our basic study is to improve our understanding to find the Cr contamination level and the ecology of heavy metal tolerance of the native bacterial flora of our study area, Chromium resistant strains were isolated from contaminated water and sediments of various tanneries. This study reports the chromium contamination and the chromium resistant bacterial populations in the Vellore District in relation to seasonal variations.

Key words: Chromium, Cr resistant bacteria, seasonal variation, vellore Dt.,

INTRODUCTION

Metals contamination is one of the major environmental problems in many countries and these contaminants generally come from various industries like leather, agricultural, textile industries etc. The most commonly occurring metals at these sites are lead, chromium, arsenic, zinc, cadmium, copper, and mercury. Presence of these metals in groundwater and soils may cause a significant threat to human health and ecological systems (Cynthia and David, 1997).

Chromium and its compounds are persistent pollutants in Palar river basin of Vellore district, Tamilnadu, India, which has become home for many tannery industries. Vellore district lies between 12º and 13º 15′ of Northern latitude and 78º 20′ and 79º 50′ of Eastern longitude. Vellore district covers an area of 4, 88,864 ha (i.e., 4888.64 Km^2). The extreme climatic condition (very hot) occurs during summer and very cold during winter seasons during March to June and November to January prevail in the district. The Vellore District has mainly four seasons, Dry weather - January to March, Hot weather - April and May, South West Monsoon - June to September and North East Monsoon- October to December. The largest number of industries in the district are belong to the category of 'leather tanning and curing' and have developed around the centres of Vaniyambadi, Ambur, Peranambut, Ranipet and Walajapet (Environmental Profile of Vellore, 2002).

Palar is one of the major rivers flowing through Vellore District (120 Km length with 4710 area of river basin). Elevated chromium concentration in the effluents from tanneries poses a serious environmental concern in Vellore district, which is the home of innumerable small and large-scale tanneries. The wastewater resulting from these processes contains high amount of chromium metal, which is harmful for environment and human health (Zayed *et al*., 2003).

Reports on the occurrence of Cr tolerance strains from naturally occurring chromium-percolated ecosystem such as tannery-contaminated soil are infrequent. There is no detailed report on the Cr contamination in the Vellore District in relation to seasonal variations. The present study reveals the seasonal variations in Cr contamination and Cr resistant bacterial populations in Vellore District.

MATERIALS AND METHODS

Sample collection: Water and sediment samples were collected from the tannery accumulated sites like Vaniambadi, Ambur, Pernambut, Ranipet and Walajapet of Vellore district, Tamilnadu, India (Fig. 1) during the year 2007 and 2008. For chromium analysis, the water samples were collected in linear polyethylene containers with polyethylene cap. The samples were preserved immediately by acidifying with concentrated to pH <2 (1.5 mL conc. HNO_3 /L sample) and stored at 4ºC for further analysis. For microbiological analysis the samples were collected in sterile containers and brought to the laboratory in iceboxes. The samples were collected every 30 days intervals for one year (APHA, 2005).

Instrumentation and chromium analysis: The microwave digestion system MARS from CEM

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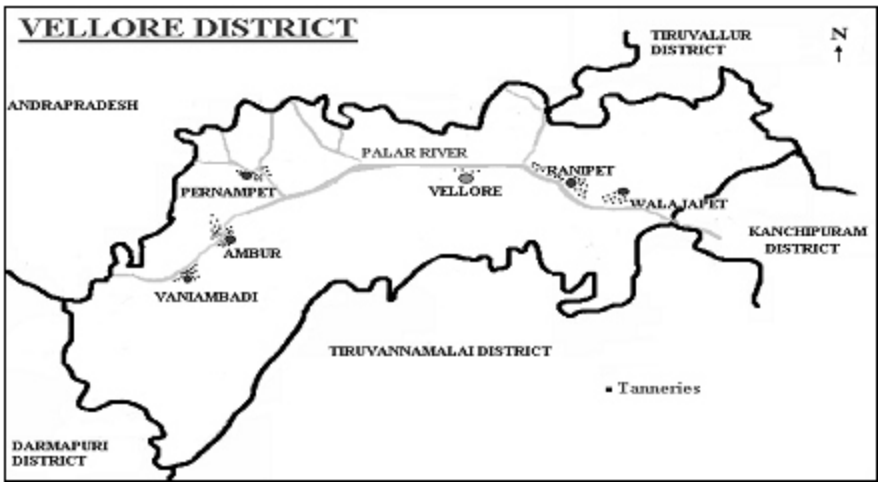

Fig. 1: Vellore District showing study locations

Table 1: Concentration of chromium in water and sediments of study locations in Palar river basin

	Vaniambadi		Ambur		Pernambut		Ranipet		Walajapet	
Chromium conc. (mg/L)	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment
Mean	0.15	366.5	0.06	282.6	0.08	184.2	0.07	351.5	0.11	346.2

Corporation with a rotor for digestion vessels was used for sample digestion. Teflon vessels were used for digestion. The pressure was maintained up to 350 psi and the temperature upto 210ºC. Seven samples were digested along with a control to know the recovery.

The digested samples were analyzed with Optical Emission Spectrometer (ICP-OES, Perkin Elmer) Optima 5300 DV and Atomic Absorption Spectrometry (AAS, VARIAN SPECTRAA). The instrument sensitivity was checked by spiking known levels of standards of 0.2, 1 and 2 mg/L levels to the Millipore water as sample. The recovery percentage was 90%.

Isolation of chromium resistant bacteria: For the isolation and enumeration of bacteria, samples were serially diluted and plated on Peptone Yeast Extract (PYE) agar medium amended with 100 mg/L of chromium in the form of $K_2Cr_2O_7$ for chromium (VI) and $Cr(NO_3)_3 \cdot 9H_2O$ for chromium (III). The medium amended with trivalent chromium was maintained at pH 3.5 to avoid the precipitation and all the plates were incubated at 37ºC for 2-4 days. The CFU on the plates were calculated and recorded for each samples. Chromium-tolerant strains representing different colony morphologies were purified on the same agar medium by repeated culturing and the representative strains of hexavalent and trivalent tolerant were maintained and stored on Nutrient agar slants at 4ºC (Basu *et al*., 1997).

RESULTS AND DISCUSSION

Chromium contamination in vellore district: Thirty-six water sediment samples were collected at every 30 days intervals in Vellore District. The concentrations of total chromium in all the study locations were given in the Table 1. It showed that the concentration of chromium in sediments were comparatively very high than in water. This might be due the presence of trivalent chromium (which is been used in tanning process) in sediments may not be leach out in to water because of its insoluble nature (Aravindhan *et al*., 2004). It was found that the concentration of chromium in Vaniambadi was more (366.6 mg/L); it also has more number of tanneries compared to other places.

Isolation and prevalence of chromium-resistant bacteria: In search for chromium-resistant microorganisms, a total of 68 Cr-resistant bacteria were isolated from soil and water samples following dilution and plating on media amended with 100 mg/L of chromium. The prevalence of chromium tolerance bacteria was 31, 23, 21, 13 and 12% in Vaniambadi, Ambur, Walajapet, Ranipet and Pernambut, respectively (Fig. 2). This prevalence was directly related to the concentration of chromium in those places. A prolonged exposure to heavy metals exerts a highly selective pressure on the microbial community, which could lead to the appearance of metal resistant strains. Bacteria can develop a high resistance to heavy metals by a variety of mechanisms to remove ions, such as adsorption to cell surfaces, complexation by exopolysaccharides, intracellular accumulation or precipitation (Saxena and Bhattacharyya, 2006). It is confirmed in the case of Vellore environment that chromium contamination had a drastic impact on the microbial population. Isolation of

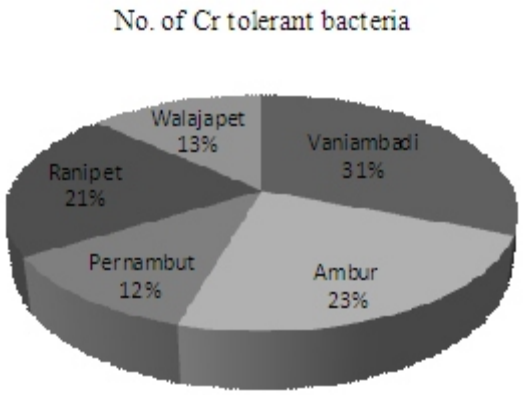

Fig. 2: Distribution of Chromium resistant bacteria in the study area

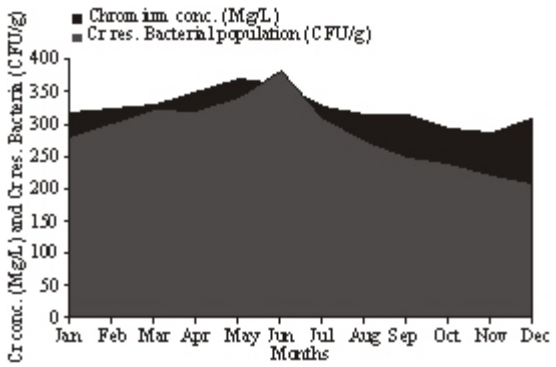

Fig. 3: Seasonal variations in the chromium concentration and the chromium resistant bacterial populations in the Vellore district

bacteria from polluted environments would represent an appropriate practice to select metal resistant strains that could be used for heavy metal removal and bioremediation purposes (Malik, 2004).

Seasonal variations in the cr concentration and the Cr resistant bacterial populations: Sampling at every 30 days for one year had shown the seasonal variations in the chromium concentration and the chromium resistant bacterial populations in the Vellore District. The Cr concentration and Cr resistant bacterial were more during summer and there is a considerable drop out in rainy season due to run off. The CFU of Cr resistant bacterial populations increases with the increased Cr concentration. The over all seasonal variation is shown in Fig. 3.

CONCLUSION

This study describes the detailed report on the chromium contamination of Vellore district particularly in our study locations Vaniambadi, Ambur, Pernambut, Ranipet and Walajapet. The chromium resistant bacterial populations were directly related to the chromium concentrations of those places. As these isolates are indigenous for these places it can be used for the *in-situ* bioremediation of chromium in soil, water of Vellore environment.

ACKNOWLEDGMENT

Authors thank to the Department of Science and Technology (DST), Govt. of India for their support and financial assistance for this project.

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