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EFFECT OF HEAVY METAL POLLUTION ON FUNGAL DIVERSITY IN SOIL AROUND INDUSTRIAL AREAS OF MYSORE, KARNATAKA

M.S.RAKESH SHARMA AND N.S.RAJU*

Department of Studies in Environmental Science, University of Mysore, Mysore - 570006, India.

ABSTRACT

The present study was focused on the microbial community of soil collected from industrial areas of Mysore district. The collected soil samples from industrial areas were analyzed for pH, Temperature, Electrical conductivity, Moisture content, Water holding capacity and heavy metal analysis such as Iron (Fe), Copper (Cu), Zinc (Zn), Nickel (Ni), Chromium (Cr) Lead (Pb), and Cadmium (Cd) and by AAS method. Physiochemical analysis was revealed that the pH from 5.82 to 6.90, temperature from 26 to 31^{o}C, EC from 45.4 to 197.8µmho/cm, moisture content from 2.45 to 3.72 percent, water holding capacity varies from 30 to 45 percent. This study was navigated to isolate the microorganisms from heavy metal contaminated site. The Iron (Fe) content were ranged between 1.96 to 3.88g/kg, Copper (Cu) content was ranging from 45 to 63mg/kg, Zinc (Zn) content varies from 35 to 58mg/kg, Nickel (Ni) content is ranging from 9.8 to 14.6mg/kg, Chromium (Cr) content is ranging from 3.8 to 13.8mg/kg. It has been found that Lead (Pb) and Cadmium (Cd) concentrations were low in most of the samples of the study area. The fungal species were identified as *Aspergillus sp., Fusarium sp., Penicillium sp., Rhizopus sp.,* and *Curvularia sp.,* in all the soil samples. Among all the species *Aspergillus sp.,*are more dominant in all soil samples of the study area.

KEY WORDS: Industrial pollution, Soil, Heavy metals, microbes.

N.S.RAJU
Department of Studies in Environmental Science,
University of Mysore, Mysore - 570006, India.

Corresponding author

INTRODUCTION

Soil is a complex, living, changing and dynamic component of the ecosystem. It is subjected to alteration and can be either degraded or wisely managed. The environmental pollution is increasing due to industrialization, urbanization, anthropogenic activities and natural sources[1-2]. Soil serves as a nutrient media for the growth of plants. In soil we can observe so many elements. Sometimes these elements occur naturally for certain extent but in some time they will enter through the human interference with the soil by many processes. Among various pollutants, heavy metals are released into soil[3] from industrial operations such as smelting, mining, metal forging, manufacturing of alkaline storage batteries and combustion of fossil fuel[4]. Moreover, heavy metals like Copper, Zinc, Nickel, Mercury, Lead and Cadmium have been reported as the most toxic pollutants[5]. The metal pollution is of great concerns, as these hazardous pollutants are accumulated in living organisms including microorganisms[6], plants[7], animals[8] and human[9] and are responsible for many metabolic and physiological disorders[10-11]. Heavy metal contamination is a serious threat to soil quality science metals persist in the soil indefinitely common source of heavy metal contamination includes applied sewage, industrial waste etc., Heavy metal contamination is known to have adverse effect on soil biological functions, including the size, activity and diversity of soil microbial community[12], influence of heavy metals on the functional diversity of soil microbial communities. Due to the solubility nature of the metal ion the bioavailability of heavy metal ions vary widely because many factors influence their concentration in soil solution. In the present study an attempt has been made to assess the microbial community of soil collected from industrial areas polluted with various heavy metals.

MATERIALS AND METHODS

Study area

Mysore is the second largest city of Karnataka, India having the population of 1.5million and it is industrially also well developed. According to the Karnataka Industrial Area Development Board (KIADB) there are about 195 industries which include large scale, medium and small scale industries too. The climate is moderate throughout the year with temperature during summer ranging from 30^0C to 34^0C.

Sampling Sites

Ten Sampling sites were identified around different industries to assess the microbial community and heavy metal concentrations of soil samples from Mysore Industrial Area and the industries are listed in the Table-1.

Table 1
Study area for Industrial Soil Samples

Sample Code	Industrial Area
IS-1	Hootagalli
IS-2	Hebbal
IS-3	Metagalli
IS-4	Koorgahalli
IS-5	Belagola
IS-6	Kadakola
IS-7	Thandavapura
IS-8	Nanjangud
IS-9	Varakud
IS-10	Chunchanakatte

Source
KIADB book let 22 Feb 2011-Mysore dist (1).

Collection of Soil samples
The soil samples were collected from 10 selected sites around the industrial areas of Mysore. The soil samples were collected randomly in replicates from the identified sites. The collected soil samples were accumulated in polythene bags and were labelled then brought it into the laboratory for experimentation. The soil samples were analyzed for their physico-chemical parameters, heavy metal analysis and the microbial community, particularly fungi.

Analysis of Physico-chemical properties of Soil
The soils samples were analyzed in laboratory for some physico-chemical properties such as pH, Electrical Conductivity (EC), Temperature, Moisture content, Water Holding Capacity were done by using standard methods[13].

Analysis of Heavy metal content of the Soil
The samples were grinded using an acid pre-washed mortar and pestle sieved by passing them through a 1mm mesh. One gram of soil of each of the samples were accurately weighed and treated with 10ml aliquots of high purity of concentrated Nitric acid. The mixture was kept on a hot plate until the sample is almost dry and then cooled. The soil samples were digested in a hot plate and then warmed in 20ml of 2M Hydrochloric acid to redissolve the mineral salts. Extract were filtered through filter papers and the volume was then adjusted to 25ml with doubled distilled water. The heavy metal concentrations such as Iron (Fe), Copper (Cu), Zinc (Zn), Nickel (Ni), Chromium (Cr) Lead (Pb), and Cadmium (Cd) were determined by using Atomic Absorption Spectrophotometer (AAS) Model-SL168, ELICO Pvt Ltd.

Assessment of Fungal mycoflora from the soil
The collected soil samples were subjected to serial dilution method[14] and inoculated on the fungal agar media. The isolation of fungal colonies and fungal species were identified by colony morphology and growth characteristics of Sabouraud- Dextrose Agar media. The composition of SDA is Agar 20g, Peptone 10g; Dextrose 40g was prepared in 1 liter of distilled water.

RESULTS AND DISCUSSION

Analysis of Physico-chemical properties of Soil
The physico-chemical properties such as pH, EC, Temperature, Moisture content, Water Holding Capacity were analyzed and it is given in Figure-1. From the above results it could be observed that the pH of the soil is varied between5.82 to 6.90. The pH values are compared with control soil sample and they were in the normal range. The pH of the soil is the measure of hydrogen ion activity and depends largely on relative amounts of adsorbed hydrogen and metallic ion. The desired pH for good vegetation ranges from 5.5 to 6.8. The pH is a good measure of acidity and alkalinity of soil water suspension and it provides a good identification of soil chemical nature[15]. The electrical conductivity of the soil is varied between 45.4 to 197.8µmho/cm where as the soil sample which were kept for control it showed the value of 66.76µmho/cm. The higher conductivity values are due to upward migration of salts along with them through cracks or fissures[16]. The observed moisture content was ranging from 2.45% to 3.72% where as in control soil sample is 5.08%. The minimum and maximum values are recorded at Chunchanakatte (IS-10) and Hootagalli (IS-1). Low organic content is because of burning out of organic matter present in top soil, low rate of humiliation and lack of microbes in top soil. The water holding capacity varies from 30% to 45% where as 68% in control soil sample. The minimum values were showed in Hebbal (IS-2) due to the presence of more clay texture in the soil. In Varakud (IS-9) the water holding capacity showed 45% as maximum except for control soil sample which holds good amount of water. Apart from this accumulation and subsequent decomposition of plant residues also result in building organic matter[17]. As the texture of the soil plays a very important role in plant species establish and develop also influences physical parameters of the soil.

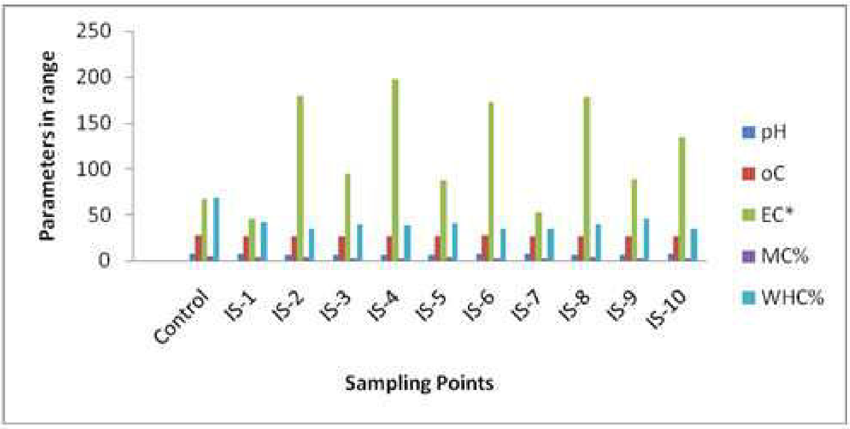
Analysis of Heavy metal content of the Soil

The heavy metal concentrations such as Iron (Fe), Copper (Cu), Zinc (Zn), Nickel (Ni), Chromium (Cr) Lead (Pb), and Cadmium (Cd) were determined by using Atomic Absorption Spectrophotometer and the data were showed in the Figure-2. Industrialization and urbanization are the two main causes for the increasing contamination of heavy metals in soil[18]. The Iron (Fe) content were ranged between 1.96 to 3.88g/kg increases amount of iron may be contributed by the weathering of rocks and also by the discharge of effluent and other wastes on surface that percolated into the ground water[19]. The Copper (Cu) content was ranging from 45 to 63mg/kg, though copper is a micronutrient of prime importance in agricultural production, it may cause environmental problem when accumulated concentration in the soils[20]. The Zinc (Zn) content varies from 35 to 58mg/kg in the soil where as 52mg/kg in control soil sample. The Zn content in effluent of industries increases soil zinc status, but this might be changed by rains[21]. The Nickel (Ni) content is ranging from 9.8 to 14.6mg/kg where as in control soil sample it is recorded as 0.05mg/kg. The Chromium (Cr) content is ranging from 3.8 to 13.8mg/kg with control as 0.05mg/kg. It has been found that Lead (Pb) and Cadmium (Cd) concentrations were low in most of the samples of the study area. Although the concentration trend of Cadmium in the soils was found lowest as compared to the other elements, it was obvious that industries effluents were highly responsible for not the increase in Fe content in the soil but also cause and increase in Zn, Pb, Cu and Cd contents. The higher amounts of heavy metals like Cu, Zn, Fe, Pb and Cd were recorded in the irrigated soil near industrial complex[22]. The high concentrations of Cu, Cr, Zn, Cd, Ni and Pb in the biota samples particularly in the bivalve species from Ennore Creek, South India may be resulted from anthropogenic influence particularly the industrial effluents[23].

Assessment of Fungal mycoflora from the soil

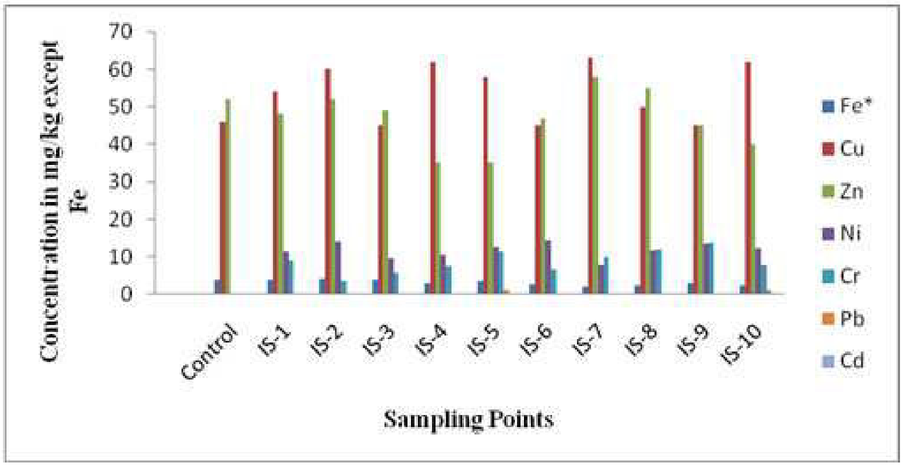
It is well known that a long-time exposure of water and sediment to heavy metals can produce considerable modification of their microbial populations, reducing their activity and their number. In the present study, soil samples collected from industrial areas of Mysore where heavy metals and other pollutants have been emitted in industrial effluents for several years[24]. Different types of six fungal species were isolated from different sampling sites and identified (Fig-3) which is compared with unpolluted soil samples where as fungal species were more in numbers than in polluted soil samples. The fungi were identified with the help of literature[25-26-27]. The fungal species were identified as *Aspergillus sp., Fusarium sp., Penicillium sp., Rhizopus sp.,* and *Curvularia sp.,* in all the soil samples. Among all the species *Aspergillus sp.,*are more dominant in all soil samples of the study area. Abundance and activities of microflora in soil strata are control by the availability of water, nutrients, pH, concentration of metal ions, hydrodynamic communication with the ground surface and so on[28]. Environmental stresses brought about by the contamination could be reason for the reduction in microbial species but increasing the population of few surviving species[29]. In Thandavapura (IS-7) soil sample the total species were more in number and in Metagalli (IS-3) soil sample the total species were lesser in number. The differences between the sampled sites regarding their richness on microbial isolates appear to be closely linked to the degree of heavy metal pollution. Generally, heavy metal pollution is soil may lead to decrease in microbial community. This is due to the extinction of species sensitive to the stress imposed, and enhanced growth of other resistant species.

Figure 1
Physico-chemical properties of soil in various industrial areas.



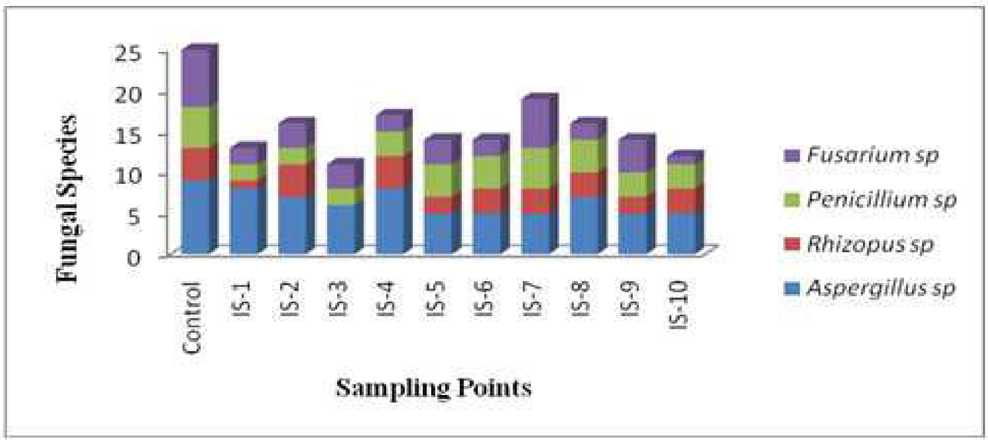
EC- Electrical Conductivity (*μmho/cm) MC- Moisture Content WHC- Water holding Capacity

Figure 2
The heavy metal concentration of soil in various industrial areas.



Fe-Iron (* g/kg), Cu-Copper, Zn-Zinc, Ni-Nickel, Cr-Chromium Pb-Lead, and Cd-Cadmium

Figure 3
The total fungal species of soil in various industrial areas.



CONCLUSION

Overall, the results revealed that, the heavy metals are introduced into the environment through so many sources which includes, decomposition of fossil fuels, smelting, glazing, electroplating etc. When the heavy metals present in the natural condition they do not act as toxic beyond certain extent. When the concentration reaches the maximum level or up to the permissible level the heavy metals will be converted into toxic in nature. The micro-organisms also play a very important role in bioremediation due to their diversity. The metal toxicity at low concentrations, metals (e.g. cobalt, copper and zinc) are essential for microorganisms, since they provide vital co-factors for metalloproteins and enzymes. At high concentrations, heavy metals however, exert inhibitory action on microorganisms by blocking essential functional groups or modifying the active conformations of biological molecules[30-31]. Our conclusion indicates that fungal population isolated from heavy metal contaminated sites has the ability to resist the metal concentrations. *Aspergillus sp.,* was the most abundant in all the sampling sites. Although this study was carried out under laboratory conditions, the results illustrate some general considerations that are important for the use of the metal accumulating microorganisms for soil bioremediation under the field conditions.

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