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Effect of heavy metals on soil microbial count in industrial area of Kanpur Nagar

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Abstract

Soil is one of the environmental natural resources which is most important for human life and is very important for human health and the quality of ecological environment. Heavy metals have a direct effect on soil enzyme activity, due to which the spatial structure of the active groups of the enzyme is destroyed, due to which the growth and reproduction of microorganisms is disrupted and the synthesis and metabolism of the microbial enzyme is reduced. Soil microbes are often used as an important indicator of soil environmental quality because their sensitivity to soil environmental conditions is greater than of larger animals or plants. Through the soil microbial changes, whether the soil is contaminated, the extent of soil pollution. The effect of heavy metal on soil microbial effect mainly includes the influence of heavy metals on soil microbial activity, the effect on soil enzyme activity and the composition of soil microbial community. Heavy metals kill microbes by binding to proteins, thus inhibiting enzymatic activity. Heavy metals are oligodynamic, meaning that very small concentrations show significant antimicrobial activity. Mercury is heavy metal, that is used in microbial control, various forms of mercury inhibit microbial action by binding to the sulfur-containing amino acid in proteins. We collected 18 soil samples from Unnao and Jajmau in which Jajmau had the highest total microbial count (bacteria) in all three layers (Upper, middle and lower) of soil and Unnao had the lowest total microbial count (bacteria) in all three layers (Upper, middle and lower) of soil but the total microbial count (fungi) in all two layers (Upper, middle) is high in Jajmau in comparision to other total microbial count (lower layer) is low.

Key Word: Soil, Industrial area, micro-organisms and Heavy metals.

Introduction

Soil is a basic resource for humans in modern social life. Soil is still the most fundamental element of human production that can tie together various economic relations of human beings (Lu and Li, 2010). Heavy metals in soil pose a serious threat to human and animal health, nor are they neutral to plants (Belyaeva *et.al* 2005) or micro-organisms (Wyszkowska *et.al* 2007). They can have inhibitory effects on the growth of fungi, bacteria and actinomycetes (Boros *et.*al 2007). A group of metal whose density is relatively high is called heavy metal. This metal is naturally present in soil ecosystems and plays an important role in biogeochemical cycles (C, N, O and P). Heavy metals in soil are divided into two categories by biochemical characteristics- one is harmful to humans, animals and crops like Pb, Cd, and Hg, the other has benefits on biology when stable but harms biology when in excess like Cu, Zn, Mn and so on (chu, 2018). An increasing industrialization, agricultural practices, man-made processes, mining and discharge of industrial sewage into natural water bodies are the major sources of heavy metal pollution in the environment (Hung, *et.al* 2021). This type of pollution is now a irreversible process and difficult to manage. Sources of heavy metals include mining oil refineries, pesticide producers, chemical

industries, informal sewage sludge and by-products from coal-burning power stations such as metal pipes. Natural sources of heavy metals in the environment are rocks and soils. Heavy metals excesses in soil originate from several sources which includes sewage irrigation, use of fertilizers and industrial soil waste and pesticides (Zhang *et.al* 2021). Soil microbes are often used as an important indicator of soil environmental quality because of their sensitivity to soil environmental conditions is greater than molluscs, larger animals or plants (chu, 2018). They inhibit the growth of micro-organisms by interfering with structure degradation and microbial digestion. This will indirectly affect the decomposition of organic matter, the absorption of nutrients by plants, the population size of the microbial community and the role of micro-organisms in beneficial biochemical reactions essential of living organisms (Xie *et.al* 2016 and Vieira *et.al* 2005). Excessive exposure to heavy metals interferes with physiological and biochemical processes of plant cells and also affects the germination and growth of plants. The effect of heavy metals accumulation natural microbial flora was studied in several researchers. Industrialization is a necessity of man but its products should not pose any threat to our environment (Loranger-Merciris *et.al* 2006). Heavy metal reduced the biomass of micro-organism and reduced their soil activity (Wyszkowska *et.al* 2008 a, Min *et.al* 2005), and although not reduce their numbers, they reduce their biodiversity (Moffett, 2003).

Micro-organism present in soil strongly influence soil processes (Garbeva *et.al* 2004), decomposition of organic matter, play an important role in the formation of soil structure and the cycling and degradation of carbon and nitrogen (Loranger-Merciris *et.al* 2006). The constituents of soil microorganisms, such as microbial community diversity, have often been identified as sensitive indicators of biological indices for maintaining soil health and quality (Bending *et.al* 2004). The soil microbial diversity is the most important functional component of the soil biota (Tate, 2004). Increased heavy metal content negatively affects soil microbial population, which may have direct negative effect on soil fertility (Ahmad *et.al* 2005).

Environmental pressure resulting from the contamination may reduce the biodiversity of microorganisms and disturb the ecological balance. However, there are reports stating that soil microorganisms may adapt to the increased, even toxic heavy metal and other Xenobiotics concentration in soil (Kozdroj 1995) by developing various mechanisms to resist heavy metal contamination (Rathnayake *et.al* 2010).

Material and Methods

Study Area- Kanpur district is located in the centre of U.P. Environmental geochemical study was conducted in and around Jajmau and Unnao industrial area U.P to find out the extent of chemical pollution due to industrial waste in soil (Gowd *et.al* 2010).Unnao and Jajmau is situated on the bank of River Ganga.

Sampling sites- Samples of Upper, middle and lower layers of soil were collected from a place at a distance of about 1 kilometer from the industrial area (Jajmau, Unnao). The distance between the three layers is 0-30cm, 30-60 cm and 60-90 cm. At each sampling slot 'V' shaped cut was made up to 15 cm depth to collect sample (Mhatre *et.al* 2022). A sharp travel and spade were used for sample collection. 18 soil samples were collected from these sites. The count of micro-organisms bacteria and fungi was carried out by using serial dilution pour plate method (Wollum, 1982). Heavy metal contaminated soil is also reduced the count of bacteria and fungi because higher concentration of heavy metals decreases the bacterial and fungal population. Such type of result in this study are given below in table-1 (a and b).

Table-1: Mean of Total microbial count of collected soil samples- Jajmau and Unnao

(a) Mean of Total microbial count of collected from Jajmau soil sample (cfu/g^{-1}).

S.No	Microbial count	Upper layer	Middle layer	Lower layer
1	**Bacteria**	4.11	3.70	3.40
2	**Fungi**	3.96	3.20	2.20

Source: Department of soil science lab (C.S.A) University, Kanpur

(b) Mean of Total microbial count collected from Unnao soil sample (cfu/g^{-1}).

S.No	Microbes	Upper layer	Middle layer	Lower layer
1	**Bacteria**	3.35	2.90	2.40
2	**Fungi**	3.60	3.01	2.60

Source: Department of soil science lab (C.S.A) University, Kapur

Result and discussion

We analyzed the total microbial count present in the industrial soil (Jajmau and Unnao) Kanpur from different places. The best indicator of soil health is microbial biomass. Bad soil has very low microbial population whereas good soil has high microbial population. The total no. of bacteria and fungi present in fertile soil sample was found to be much higher as compare to total no. of bacteria present in metal contaminated soil sample (Mhatre *et.al* 2022). Heavy metals have a strong affinity towards with some biological macromolecules such as enzymes activity center, electron-donating groups, nucleotides and phosphate molecules which results in the structural instability of biological macromolecules and thus bacteria are get inhibit in presence of high concentration of heavy metals (Chu *et.al* 2018). Similar to our results also observed the reduction of total microbial count in metal containing soil samples (Oliveira *et.al* 2005). The total microbial count of two places (Jajmau and Unnao) are bacteria and fungi is high in Jajmau in comparision to other microbial count is low.

Conclusion

Industries are one of the sources of heavy metal contamination in environment, which affects the total microbial count of bacteria and fungi population. Prevention of seed germination is not good sign for environment sustainability. Thus we must develop the new environment friendly techniques to remediate heavy metal from environment.

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