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INDUSTRIAL POLLUTANTS: HAMPER OR ENHANCE SOIL BIODIVERSITY

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Abstract

Industrial waste is one of the most pertinent sources of contamination in the soil environment. The industrial effluents which is being released is discharged untreated on land or into water sources due to lack of treatment units. Tannery and leather industries contribute huge quantity of pollutants. These discharges are rich in major, minor nutrients as well as heavy metals which cause indicative changes in cycling of nutrients and various processes occurring in soil ecosystem. However, it is reported that the industrial effluents has both positive and negative effects on soil microbes. Some microbe's growthis stimulated whereas some have depressive effects. Hence, both aspects have been discussed in this article.

Introduction

The soil is a three-dimensional, dynamic and a habitat for a vast, complex and interactive community of soil organisms whose activities largely determine its chemical and physical properties.Rapid industrialization and aggressive economic development has significantly impacted biodiversity leading to a gradual and in some cases rapid extinction of various species, loss of green cover and global environmental degradation.Approximately,more than 70,000 chemical industries, around 2,000 leather industries are located across the country. There are 11 major iron and steel industries in which, India stands second largest producer in 2019 in the World.According to CPCB, 2020 the State wise and Category wise distribution reveals that States of Maharashtra, Uttar Pradesh, Gujarat, Andhra Pradesh and Tamil Nadu have substantially large number of industries in the identified sectors and that the sugar sector has the maximum number of (i.e. 392) industries, followed by pharmaceuticals, distillery, cement and fertiliser. It also indicates that agro-based and chemical industries have major shares of 47% and 37% respectively, of the total number of industries. About 77% and 15% of the industries is predominantly water polluting and air polluting respectively and 8% of the industries are potentially both air and water polluting.The five most common industrial chemicals released are sulphuric acid, ethylene, sodium hydroxide, propylene and nitrogen gas.The huge amount of heavy metals and other pollutants released have negative impact on environment causing toxicity to flora and fauna.

Effect of Pollutants on Soil Microbes

Soil is one of the most biologically rich habitats on Earth, with greater biodiversity per unit area, and is considered as a centre for biological interaction (Bardgett and Putten, 2014). Fertile soils support highly abundant and diverse communities of organisms which range in body size from a few micrometers for some bacteria to several meters in length in the case of some earthworms (Table.1). Microbial activity plays vital role for the biogeochemical cycling of elements in the environment so any impairment of microbial growth will positively have negative effects on microbial activity. These microorganisms (bacteria and fungi) demineralize organic matter to carbon dioxide, water, and various inorganic salts and also involved in catalysis and synthesis of organic matter in the aquatic and terrestrial environments.Major transformations, such as nitrogen fixation, nitrification and carbon mineralization may be impaired due to pollutant impact.Effluents from agro-based industries contain considerable amounts of un-degraded carbohydrates, proteins etc., there continuous release of effluents is quite toxic and cause problems for the survival of the soil micro flora.

Table 1.Relative numbers and approximate biomass of the soil microbiota in a fertile soil (Metting, 1993).

Organisms	**Numbers**		**Biomass (wet. Kgxha^{-1})**
	Per m^2	**Per g**	
Bacteria	10^{13} -10^{14}	10^8 -10^9	300-3000
Actinomycetes	10^{12} -10^{13}	10^7 -10^8	300-3000
Fungi	10^{10} -10^{11}	10^5 -10^6	500-5000
Microalgae	10^9 -10^{10}	10^3 -10^6	10-1500

Heavy industry, e.g. mining and metallurgy is one of the most significant sources of heavy metal pollution of soils. Some metals (e.g. Fe, Zn, Cu, Ni, Co) involved in the metabolism and redox processes are of vital importance for many microbial activities when occur at low concentrations. However, high concentrations of heavy metals may have inhibitory or even toxic effects on living organisms (Bruins *et al*., 2000). The most harmful heavy metals are Cd, Pb, As, Cu, Ni, etc. (Chen *et al*., 2000). These metals tend to precipitate phosphaticcompounds and catalyze their decomposition. Microorganisms are the first group that undergoes any direct and indirect effect of heavy metals in the soil environment. For ex: About 100 ppm of zinc in soils may inhibit nitrification processes and about 1000 ppm inhibits themajority of microbiological processes in soils.

Heavy metal contamination due to industries results in reduction of microbial biomass and even if they do not cause the reduction in their number-they reduce biodiversity or disturb the community structure.Industrialization has significantly impacted biodiversity leading to a gradual and in some cases rapid extinction of many species.The bacterial community is more sensitive to increased concentrations of heavy metals in soils than the fungal community. A large number of chemicals including acids, alkalies, oil detergents, dyes, aromatic amines etc. are used during processing operation like scouring, bleaching, mercerizing, dyeing, printing and finishing in textile industries which generate huge amount of pollutants causing adverse effects on soil bio-data in that area.High concentrations of heavy metals on soil from industries pollutants have been shown to adversely affect the size, diversity, and activity of soil microbial populations. The risk of heavy metals presence in soil is related to the fact that they can accumulate for long time in toxic doses, and cannot be naturally degraded like organic pollutants. Microbialpopulation was found to be diverse in different ecosystems, based upon the nature of soil such as industrial, agriculture, forestry etc.

However, there are several studies which shows negative or decline in soil microbial activity due to addition of industrial pollutants but few researchers also reported its positive correlation. Table 2 shows the biological characteristics of control and test soil samples of leather industrial area.

Table 2.Biological characteristics of control and test soil samples of leather industrial area (ReddiPradeep and Narasimha, 2012)

Analyzed microorganisms [CFU×g^{-1}]	Test	Control
Total number of bacteria	107×10^4	52×10^4
Total number of fungi	5×10^4	2×10^4

According to Monanmani*et al*., 1990, discharge of effluents from alcoholic and chemical industries into soil led to increase microbial population and microbial activity. Similarly, soils when receive effluents from pulp and paper mills recorded maximum counts of bacteria and fungi .Mythili and Karthikeyan (2011) reported that several organisms in the tannery effluent utilize phenol and other pollutants as their carbon source to produce metabolic energy. Zahoor and Rehman (2008) reported that bacteria, yeast, algae, protozoa and fungi found in effluents have developed capabilities to protect them from the chemical constituents and heavy metals present in the effluents. Murugan*et al.* (2011) isolated *Aspergillusniger*capable of producing tannase which was able to degrade tannin, a major constituent of tannery effluent. Higher microbial population in the test soil possibly due to the presence of high organic matter in acidic effluents. Similarly, Narasimha et al., (1999) observed that microbialpopulations were increased in soils polluted with cotton ginning mill effluents.

Additionally, by increasing the sugar industry effluent concentration in thecontrol sample, the cellulase activity was increased, maximum at 50%, there after decreased. Decreased activity of cellulase at higher concentrations of effluents may be due to the exposure of cell free enzyme to highly concentrated effluent.Pollution induced bacterial community shift and abundance of *Proteobacteria* were observed in soils under long-term exposure of heavy metals. In another study, the higher percentage of *Proteobacteria, Firmicutes, and Actinobacteria* were noticed in long-term polluted soils in which hydrocarbon was the main contaminant.

Conclusion

The discharge of effluents from industries altered physico-chemical properties of soil and affect soil micro-flora. Both positive and negative effects have been seen on biodiversity. Measures should be taken by the industries for safe and proper disposal of effluents after treatment to protect natural resources.

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