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Bioremediation: Tools For Environment Protection

[1]Guguloth Ramesh and [2]Bikramjit Deuri
[1]M.Sc. Ag. Agronomy, AC&RI- Coimbatore and TNAU Coimbtore
[2]SCS College of Agriculture, Assam Agriculture University, Assam

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Abstract

Bioremediation plays a major role in the breakdown, elimination, immobilization, or detoxification of different chemical wastes and physically hazardous components from the surrounding environment by means of the ubiquitous activity of microorganisms. The basic concept is to decompose and convert pollutants into less dangerous forms. It is possible to do both in-situ and ex-situ bioremediation, depending on several factors including the characteristics of the site and the kind, concentration, and cost of the pollutants. Bioremediation is the least expensive, most effective, and ecologically friendly way to manage the polluted environment.

Keywords: Bioremediation, Degradation, Microorganisms, Eco-friendly

Introduction

Bioremediation and natural reduction are also thought to offer answers to emerging pollution problems; microorganisms are important in cleaning up contaminated settings. Numerous microorganisms are involved in the bioremediation process, including aerobic and anaerobic bacteria, fungi, and bacteria. Bioremediation plays a major role in the breakdown, elimination, immobilization, or detoxification of different chemical wastes and physically hazardous components from the surrounding environment by means of the ubiquitous activity of microorganisms. The basic concept is to decompose and convert pollutants into less dangerous forms. Abiotic and biotic environments are the two main categories of elements that influence the rate of degradation. Today, there are many different methods and strategies employed in the bioremediation process.

Bioremediation:

Bioremediation technologies were widely applied and are continuing developing rapidly today. The microbial procedure has shown to be a stable and effective way to clean up unclean places since it is not harmful to the environment. The ultimate goal of bioremediation techniques has been to economically and environmentally restore polluted places; these approaches have come a long way over the previous twenty years. Researchers have created a number of bioremediation techniques that help polluted environments recover. One kind of bioremediation involves reducing, detoxifying, degrading, mineralizing, or converting more dangerous pollutants into less dangerous ones.

Role of biotechnology in bioremediation:

There are various examples where the natural capabilities of biological forms have been increased by the use of biotechnology. Bacillus thuringensis has been used to clean up oil spills, and Deinococcus radiodurans, a kind of radioactively resistant bacteria, can break down and ingest the ionic mercury found in highly radioactive nuclear waste. Here is an illustration of how the combination of lpp-ompA, which serves as an anchor, rat metallothionein (MT), and Neisseria gonorrhoeae protein IgA protease results in bacterial cell walls that are coated in polypeptides that bind metal ions. Furthermore, plant transgenics has become a powerful tool for improving the efficiency of phytoremediation of organic matter-contaminated soil. The goal of genetically modified techniques is to accelerate the rate of pollution breakdown within plants or to release more enzymes from roots that accelerate the breakdown of pollutants outside of plants. The CYP and GST genes are frequently the modified targets for encouraging the breakdown of organic pollutants in plants. According to a recent study, transgenic Medicago sativa plants that co-express human CYP2E1 and GST may be highly helpful for phytoremediation of organic pollutants.

The general approaches to bioremediation are:

- Iintrinsic (natural) bioremediation,
- Bio simulation
- Bio augmentation (addition of microbes).

Advantage:

- For contaminated materials like soil, it takes some time to be an efficient waste treatment process. Biodegradative microorganisms reduce the amount of germs that can degrade the contaminant.
- It does not use any hazardous chemicals and is a practical and cost-effective technique compared to other traditional methods that are frequently used for the cleanup of toxic hazardous waste for the treatment of oil-contaminated locations.

- It requires relatively little work and can often be performed on-site on a regular basis without interfering with typical microbial activity. nutrients that are supplied to encourage rapid and strong microbial development, especially fertilizers.
- The current method of clearing the environment of major pollutants provides a sustainable environmentally friendly opportunity because they are easy to use, low labour cost, and inexpensive; Contaminants are eliminated rather than merely relocated to other areas;
- They are non-intrusive, which could permit continuous site usage.

Disadvantages:

- It is restricted to materials that break down organically. Not every substance breaks down completely and quickly.
- Some unique products of biodegradation might persist in the environment and pose a greater threat than the original substances.
- Exceptionally specific and ecologically benign biological processes include the presence of metabolically active microbial populations, favorable environmental growth circumstances, and the availability of nutrients and toxins.
- Facilitating the shift from large-scale field operations to bench and pilot-scale operations is a challenging process. Contaminants may be present in solids, liquids, or gases.
- It usually takes longer than other recommended treatment techniques, like burning or excavating dirt.

Limitations of Bioremediation:

- Biology functions on a highly specialized level. For a site to be successful, it must have metabolically competent microbial populations, optimal environmental growth conditions, and appropriate pollution and nutrient concentrations.
- Why It is difficult to scale up the bioremediation approach from batch and pilot level investigations for large-scale field operations.
- More research is required to design modern engineer bioremediation systems suitable for areas with composite combinations of toxins that are not evenly distributed in the environment. It could be found as liquids, solids, or gases.

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- Bioremediation takes longer than other treatment techniques, such as digging up and removing soil from contaminated areas.
- Because there is disagreement about what is considered clean, they are unsure if remediation is 100% complete. As a result, assessing the efficacy of bioremediation is difficult, and these treatments lack a defined endpoint.

Conclusion

Biodegradation, which makes use of microbial activity, is a very attractive and successful substitute for methods of cleaning, managing, remediating, and recovering from a contaminated environment. The rate at which undesirable waste products break down is determined by the competition of biological agents, such as bacteria, fungus, and algae, for a finite supply of essential nutrients, unfavorable external abiotic conditions, and low bioavailability. The sort, concentration, and expense of toxins as well as the characteristics of the site all affect how effective bioremediation is. The most suitable and successful bioremediation strategy should be selected to effectively clean polluted areas based on a variety of geological site characteristics, including soil, pollutant kind and depth, human habitation site, and the effectiveness of each bioremediation process.

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