

Chapter 9

Extremophiles and Their Application in Bioremediation

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ABSTRACT

A microorganism dwelling in severe environmental conditions is termed an extremophile. These unfavorable environmental conditions include high salinity, toxin compounds, heavy metals, unfavorable temperature, and extremely acidic and alkaline pH. Microorganisms belonging to prokaryotes include true bacteria and archaea bacteria which prevail in harsh environments. In recent years, extremophilic, basically, archaea bacteria have been reported for their immense potential application in the bioremediation process. Bioremediation is a technique that utilizes microorganisms for the decomposition of organic and inorganic pollutants; anthropogenic activities are the basic cause of soil pollution, water pollution, and air pollution globally. Extremophiles are capable of producing enzymes that are thermolabile and can function normally even in extreme conditions. These enzymes and proteins can be utilized in the bioremediation process under extreme pH, heavy metal stress, and unfavorable temperature conditions. In this chapter, the role of extremophiles in bioremediation is discussed.

INTRODUCTION

Many living organisms are able to interact with pollutants through a biological method so as to degrade the harmful pollutants in a very slow process; depending upon their capability, the rate of this process can be helpful in controlling the pollution. Due to the involvement of organisms in remediation, their biological processes rate, lower costing, no management issues making bioremediation an efficient and ideal biological process compared to physical and chemical methods of remediation. Numerous bacteria, fungi, and some plants are able to neutralize the pollutants through degradation to elementary constituents or to non-harmful form (Azubuike et al., 2016). Bioremediation is the process of detoxification of pollutants present in the environment and the hazardous waste material components into mild or attenuated or less toxic components by means of biological metabolic processes, i.e., degradation, mineralization, immobilization, removal, transformation by the action of living organisms primarily microorganisms, the enzymes they produce or by some green plants as a treatment sites contamination to the most original form (Azubuike et al., 2016; Dua et al., 2002). It can be applied to clear contamination in soil, groundwater, ponds, waste sludge, or streams using microbial action of natural or genetically modified microbes. A proper favorable environment for optimized growth can be provided via engineering designs; thus, the technique can be implanted in contaminated sites. Figure 1 describes the basic principles of bioremediation.

SIGNIFICANCE OF BIOREMEDIATION

Bioremediation is becoming a major decontamination method due to its approach in most human toxic waste treatment. Pollutants are becoming direct or indirect issues of public health, environmental contamination, and the cost of treating the industrial, municipal, industrial, agriculture waste varies on their treatment methods. All these wastes are responsible for polluting water resources and soil, which are directly related to all living life. As water and soil are directly related to each other, there is the exchange of everything between the two, whether it's the organic decomposed plants, animals, or the leaching of minerals to direct contact of aquatic life to land life. Bioremediation is an inexpensive methodology critically needed for the removal of pollutants (Azubuike et al., 2016). Bioremediation is effective in removing petroleum industry pollutants that are organic hydrocarbons such as aromatic, alkanes, and alkenes compounds. Subsurface and soil contamination due to leakage of pipelines, oil spills, automobile industries, manufacturing, etc.

Agriculture is also untouched from contaminating terrestrial, aquatic life forms. Due to the application of different pesticides in different forms, i.e., powder, aqueous solutions, emulsions, sprays, etc., they enter the environment in different forms. Structurally they are inorganic and organic compounds mostly comprising Cl, P, N, and other complex forms (Dua et al., 2002). They are stable in the environment for many years or even decades, causing ecological instability and health issues. Fertilizers, on the other hand, pollute the surface or groundwater by leaching or runoff. Eutrophication of this runoff causes intoxication in aquatic life; phosphate, nitrates, and nitrites are the leached runoff of agriculture (Dua et al., 2002). Bioremediation helps in the transformation, assimilation of these chemicals and also providing the breakdown products of these complex chemicals to plants in simpler form in some cases (Azubuike et al., 2016).

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