Chapter 6
Technological Approach of Bioremediation Using Microbial Tools:
Bacteria, Fungi, and Algae

Mostafa M. El-Sheekh
Tanta University, Egypt

Yehia A-G. Mahmoud
Tanta University, Egypt & Albaha University, Saudi Arabia

ABSTRACT

Bioremediation is applied to eliminate various contaminants, such as organic, inorganic or other pollutants from the environment. Environment worldwide is under great stress due to industrialization and human interfering on the limited natural resources. The release of chemicals pollution needs several techniques to treat some of these chemicals, but due to their cost, new technologies should be developing in order to create cost-effective and eco-friendly bioremediation technologies for environmental conversions. Bioremediation is an increasingly popular using microbial and algae strains for degrading waste contaminants. It is using of microorganisms and its enzymes to protect the environment from severe pollution. Bioremediation may be employed in order to eliminate specific contaminants, such as chlorinated pesticides or other pollutants from the environment. Microorganisms degrade the different pollutants in a natural environment but some modifications can be done to enhance its degradation efficiency at a faster rate in a limited time frame by using the genetically engineered microorganisms and microalgae. In this chapter, the role of the bacteria, fungi and algae in bioremediation of different environmental pollutants was highlighted.

INTRODUCTION

Bioremediation is a process in which organisms or microbes are used to remove or neutralize harmful pollutants from contaminated sites including water and soil. It requires a technique to select organisms capable of uptake or release some enzymes which can degrade these pollutants. Using biological ma-

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terials, it is more effective than the traditional strategies because bioremediation strategies can be used directly at the site of contaminant without the need to transfer contaminant materials (Singh & Gupta, 2016). In the bioremediation process, bacteria alone, consortia, or combination of bacteria and fungi can be used for effective biodgradation (Fuentes, Barra, Caporaso, & Seeger, 2016; Ma, Ding, Peterson, & Daugulis, 2016). Bacteria, Fungi and algae are known for bioremediation of toxic hazardous materials including heavy metals. In order to increase its ability to degrade bioremediation, efforts have been done for exploiting diverse bacterial detoxification genes. Genetic engineering is a tool for manipulation of bacterial genome which can adapt and enhance the bioremediation potential of toxic metal detoxification that is not usually performed by normal bacteria (Das, Dash, & Chakraborty, 2016). Deshmukh, Khardenavis, & Purohit (2016) discussed the role of fungi in bioremediation due to their robust morphology and diverse metabolic capacity. Fungi possess multiple modes employed for detoxification of different toxic pollutants through the powerful enzymatic machinery. Algae also play an important role in the bioremediation of wastewater and decontaminate pollutants such as organic and inorganic compounds. Algae can be used in the free form or immobilized form for bioremediation of toxic heavy metals. Some treatment technologies involve the use of microalgae for effluent treatment, either as single species (Voltolina, Gómez-Villa, & Correa, 2005) or as mixed cultures/consortia (Tarlan, Dilek, & Yetis, 2002l; Bhakta, Lahiri, Pitman, & Jana, 2015) to treat and remove nitrogen, phosphorus and chemical oxygen demand, from different types of effluents. Microalgae are also able to remove heavy metals from contaminated wastewater (Dwivedi, 2012; Prabha, Soni, Gupta, & Sonal, 2016).

WHY USE BIOLOGICAL SOURCES IN BIOREMEDIATION?

Microorganisms in general have effective ability to rapidly multiply and increase in huge numbers when be inoculated to decontaminate polluted area, when compared with chemical means. Antizar-Ladislao, Spanova, Beck, & Russell, (2008) indicated that microorganisms possess efficient enzymatic pathways able to eliminate or modify different pollutants. Moreover, different microorganisms could be added to polluted area (called inoculation) to enhance biodegradation rate. The inoculums may be a mixture of nonindigenous microbes from various polluted sites (specially selected and cultivated for its various pollutant degrading capabilities) or it may be a mixture of microbes selected from the site to depolluted or mass-cultured in the laboratory. Addition of nutrients along with inoculated process shows enhanced results for bioremediation (Boopathy, 2000).

This chapter deals with the significance of bioremediation, as it plays crucial role in the restoration of degraded land which is an important conservation effort for sustainable development and environmental management. The current chapter will summarize the available information on various attributes of microbial utilization for bioremediation. The gathered information is valuable to design reactors for contaminants elimination at regional and national levels.

MICROORGANISMS AND BIOREMEDIATION

The recent classification of living organisms based upon DNA and RNA has classified it; into three domains: eubacteria, Archaea, and Eukarya. Bacteria are prokaryotic microorganisms lacking true nucleus and other eukaryotic organelles such as mitochondria…etc. There are two types of bacteria according