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Biodegradation of Environmental Pollution through Microorganisms

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Abstract

One of the best ways to eliminate environmental pollutions is biodegradation using microorganisms and plants. Biotechnology is key science and technology that is rapidly examining and developing in various environmental fields. Environmental biotechnology, in fact, allows to help preserve and develop the environment by utilizing the potential of plant biocatalysts and natural and recombinant microorganisms (Yeasts, fungi and bacteria). In this regard, biotechnology has contributed to the development of microorganisms and plants using genetic engineering technology and recombinant DNA. It has been effective in the purification of environmental pollution such as soil and water pollutants, and the removal of hydrocarbons from oil and heavy metals, and has been able to produce genetically modified organisms with high efficiency. Also, by creating advanced technologies related to the production of biofuels and bioplastics, it has significantly contributed to protecting health and preventing environmental pollution. Iran, as a developing country, is involved with numerous pollutants and various environmental crises. Therefore, it is necessary to plan and take necessary actions in the field of research and development of environmental science and biotechnology. In this work, a general overview of the most important applications of environmental biotechnology has been done to eliminate environmental pollution.

Keywords: Environmental Biotechnology; Biodegradation; Environmental Pollution; Microorganism; Biofuel

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1. Introduction

Biotechnology is a combination of biological processes and technology, whose rapid advances in recent years have led to effective solutions to environmental preservation [1]. Today, environmental pollution is one of the important issues facing various communities and pollutants are considered as a source of environmental disruption, and water, soil and air are directly exposed to pollution from industrial activities as key components of the environment. The increase in greenhouse gases from fossil fuels and the accumulation of incalculable artifacts has made the world an inappropriate place for life, which has forced countries to reduce their environmental pollutions. In this way, biotechnology is suggested as a powerful tool for solving the challenge. Today, the main source of energy production is fossil fuels such as oil. This source of energy has caused a severe pollution of the environment. One of the alternatives is bioethanol and biodiesel production through biological processes. Other pollutants of the environment are the accumulation of undestructible polymers. Biotechnology has suggested the use of biopolymers and bioplastics as a substitute and compatible with nature.

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Regarding the possibility of using microorganisms and biocatalysts in comparison with other chemical processes, environmental biotechnology promises a better future for environmental preservation. Recycling industrial effluents and using them to produce products, enrichment of agricultural waste such as wheat bran and sugar beet pulp, production of citric acid from apple waste and pulp, are among these applications. Also, increasing the absorption and resistance of microbes in the absorption of heavy metals and radionuclides and toxic residues contributes greatly to ecosystem health, soil and water biofiltration, and the removal of pollution from air [2]. Two important aspects of environmental biotechnology include the detection and control of pollution (using biosensors and biological control) and refinement of post-production pollution (biodegradation) [3].

The following is a brief overview of the most important applications of environmental biotechnology for controlling environmental pollution.

2. Detection and Control of Pollution

2.1. Microbial biosensor

The biosensor is a tool for tracking, transmitting and reporting information related to physiological and biochemical changes. Biosensors have a sensitive biologic element or biomarker (enzyme, antibody, microorganisms or DNA) that are associated with a physical transducer [4]. Uses of biosensors include identification of fluorescence toxicity [4], water quality control [5], biological control of atmospheric quality [6] and biological control of soil pollution [7].

2.2. Biomarkers

Chemical measurements are used to determine the level of pollution that used in biological control [8]. A number of organisms respond to environmental influences through changes in biological yields or measurable chemical compounds [9].

3. Pollution Refinement (Biodegradation)

Environmental hazards that occur as a result of the accumulation of toxic chemicals or other waste and pollutants can be reduced or eliminated by biotechnology in the form of biodegradation/decomposition. Biodegradation uses natural and recombinant microorganisms (yeasts, fungis and bacterias), enzymes and all cells [10].

3.1. Application of microorganisms in biodegradation

A number of microorganisms have the ability to decompose hazardous chemicals [11], and microorganisms eliminate the substances in the environment for their growth and metabolism [12]. A number of organisms that are capable to biodegradation (including pollutant degradation, survival and better cloning) are isolated from contaminated environments and then modified by mutation or engineering methods and are genetically modified to enhance their efficiency [13]. Some of the most important applications of these engineered microorganisms are biodegradation of wastewater, contaminated soil and hydrocarbons.

3.1.1 Biodegradation of wastewater

The molecular techniques used by nucleic acid probes to detect pathogens and parasites were expanded in the 1980s [14]. Microbial pathogens are one of the most important health problems in water and sewage. Escherichia coli is used as a marker for the examination of water pollution to the faeces. Normal methods for identifying pathogens in water, as well as time consuming and costly, are also not accurate. Polymerase chain reaction can be a good alternative to common tests. By using the above method, you can even detect a bacterium in 100 ml of water [15]. Biological treatment of water is done by decomposing microbes which are often aerobic. Biological degradation of each compound requires the presence of specific microorganisms with resistance ability to the composition and content of the special enzymatic system [16]. The selection of appropriate microorganisms for wastewater is difficult because many of these substances are also toxic to microorganisms, so pre-treatment is considered [17]. The process of sulfur reduction from wastewater is done by using wastewater treatment by bacterias whitout sulfur, which is a kind of photosynthetic bacteria under light and anaerobic conditions to produce a large amount of useful biomass with low carbon dioxide, which is one of the greenhouse gases [18].

3.1.2 Biodegradation of soil

Soil pollution from the environmental point of view is important because soil is a natural filter for groundwater. Obviously, soil pollution is an undesirable event, and it should identify a variety of human intervention and define a boundary for each of them [19]. In a study conducted by Ahmadi et al. (2014) [20], Hamedan's soil was found to be polluted with petroleum compounds, and they used the Pseudomonas alcaligenes bacteria as an

effective strain to remove various types of petroleum compounds.

3.1.3 Biodegradation of hydrocarbon

One of the pollutions of groundwater, soil and sea is the presence of hydrocarbons [21]. Various microorganisms can be used in this regard. Seddigh Bayan et al. (2011) [22] at the Tabriz Oil Refinery examined the ability of biodegradation of naphthalene using soil bacteria. They concluded that using a biological removal method, naphthalene could be decomposed and disrupted into polluted soils and wastewater, and eventually recovered polluted soils.

3.1.4 Biological absorption of toxic ions

Metal ions can be attached to the cells by physiochemical mechanisms based on the bacterial race and environmental conditions. The cell wall of the bacteria is polyelectrolyte and interacts with the ions in the solution [23]. By creating recombinant bacteria whose cell walls are more capable of absorbing ions and reducing their pollution, the toxicity of ions can be reduced.

4. Prevention of Pollution Production

In fact, here are some methods that prevent the production of pollutant materials or wastes and help maintain and improve the environment.

4.1. Biofuel

Bioethanol and biogas are produced using agriculture, waste and vegetable oils, and improve the industry for energy storage, resource conservation, waste management, and environmental protection [10]. Biogas is a methane-rich gas produced by anaerobic bacterial activity [24]. Algae is one of the most important producers of biofuels. In algae, extracellular polysaccharides such as provinces, hyaluron, alginate, levan and chitosan are water soluble. In transgenic algae, levan saccharose has shown that the diffiusivity of the cell walls increases, and hyaluronan and chitin are increased and ultimately increase cellulose production and bioethanol production increases [25].

4.2. Bioplastics

Plastic production of fabricated polymerase consumes a large part of non-renewable resources, which is a big environmental problem [26]. The production of new biomaterials such as bioplastics based on sugar, oils, proteins, fibers and other natural substances extracted from plants, prevents the use of non-renewable resources, such as fossil fuels, reducing greenhouse gas emissions and consuming less energy [27].

4.3. Conversion of heavy crude oil to light petroleum

Recently, conversion of heavy crude oil into light petroleum has been reported using microorganisms. For this purpose, various bacteria have been used, such as: Sulfolobus, Pseudomonas, Achromobacter and Thiobacillus. Resistant strains are added in the form of highly concentrated aqueous solutions to crude oil and heated at temperature between 50 and 65 °C. The effect of microorganisms on crude oil depends on both microorganisms and crude oil type. Usually, processed crude oil becomes lighter and the amount of sulfur, nitrogen, oxygen and heavy metals is reduced by 24-40% [28].

5. Conclusion

According to studies, it has been determined that biotechnology has a great application to protect the environment. Biodegradation is a natural process that decomposes pollutants, instead of simply is buried the pollutants and The responsibility for their removal is deposited to the next generation. In addition, from the general viewpoint, biodegradation is preferable and many global organizations promote the use of it to eliminate environmental pollutants. Using recombinant DNA technology, biotechnology has been developing and increasing the efficiency of microorganisms to environment cleanup and eliminate pollutant materials, and has achieved a great deal of achievement in this regard. In addition, the production of biodegradable materials (Such as bioplastics or biofuel) helps prevent environment pollution. Iran, as a developing country, is involved with several pollutant factors and various environmental crises, among which the most important are pollution of hydrocarbons, various waste, urban-industrial wastewater and heavy metals. Therefore, both these pollutants should be cleaned and should be avoided by more environmental pollution. Therefore, it is essential that planning and necessary proceeding be taken in relation to research and development of environmental biotechnology in the country.

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