Chapter 11
Biotechnology in Waste Treatment and Recycling

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ABSTRACT

Biological processes are demonstrating tremendous advancements among developing technology. Biological elements are employed as degraders in these processes, which eliminate contaminants from raw waste. Biotechnological approaches are utilised in environmental engineering for the treatment of wastewater, gas, and solid waste. Producing renewable energy sources like biogas and hydrogen is another potential application of these processes. Environmental engineers frequently use waste treatment systems such as biotrickling filters, composting units, anaerobic treatment, oxidation ponds, and activated sludge processes to reduce pollution. This chapter aimed at assessing several treatment methodologies and analysed the influence of biotechnology on waste management.

INTRODUCTION

Biotechnology has certainly captivated the attention of all individuals, despite the fact that there have been numerous new technologies introduced since the 1970s. It demonstrates that it has the potential to significantly impact all major sectors of the economy and generate substantial revenue. Its impacts on healthcare, food processing, forestry, agriculture, environmental protection, and chemical and mineral production have been substantial (Gavrilescu & Chisti, 2005). The commercial application of biological materials in the production of products is known as biotechnology. Due to the growing interest in these

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biotechnological processes, numerous institutions and workgroups delineate biotechnology distinctly (Segundo et al., 2024).

A wide range of disciplines are included within biotechnology, such as microbiology, biochemistry, genetics, physics, botany, zoology, chemical engineering, and food engineering. Biotechnology is defined by its 1919 coiner, Karl Ereky, as the transformation of inert substances into useful end products by means of the action of living organisms. Biotechnology is defined by the European Federation of Biotechnology. When living things, their components, cells, and molecular counterparts are used to create goods and services, this process is called biotechnology. The interdisciplinary character of biotechnology was brought to light by this argument (EFB, 1999). In their 2005 report, the OECD offered a new definition of biotechnology. The term "biotechnology" is used in this document to describe the process of using scientific and technological concepts to alter materials, whether they are living or not, in order to create new information, products, or services. Everything from bacteria and enzymes to animal and plant cells is considered a living thing. The phrase "goods" in the description refers to products from the food, beverage, pharmaceutical, and biochemical industries. The aforementioned phrase "service" elucidates the management of environmental degradation. The OECD paper provides a more appropriate definition of biotechnology in relation to the treatment of waste materials (Ogidi, 2022).

According to the OECD (2005) and Ogidi & Akpan (2024), biotechnology encompasses a wide range of practices, including phytoremediation, fermentation in bioreactors, bioprocessing, bioleaching, biofiltration, biopulping, biodesulphurization, biobleaching and bioremediation. To manage garbage and reduce environmental damage, complicated and expensive methods are required. This leads to a never-ending stream of studies investigating cutting-edge methods. The study of microbiological processes is one of the most intriguing aspects of this field of study. The methods under consideration aim to break down waste while also creating new products. Living creatures such as yeasts, bacteria, fungus, and algae are utilised in this process. Numerous studies (Ozdamar, 2009; Buyukgungor & Gurel, 2009; Yadav et al., 2020), have shown that these businesses' products and processed waste materials exhibit significant variance among countries. Waste management and cancer therapy are only two of the many diverse applications of biotechnology.

Biotechnology offers advantages such as an improved environment, enhanced diagnostic and therapeutic techniques, superior products, and alternative energy sources. Currently, environmental contamination is a significant issue in all nations worldwide. Biotechnology provides numerous therapeutic approaches to address this pollution issue (Ogidi & Akpan, 2022). This chapter thoroughly examines the elimination of waste by biotechnological treatment, including examples of studies on waste treatment via biotechnological processes in environmental engineering.

SOURCES OF WASTE

Waste is an omnipresent result of human activities and natural processes, affecting the environment, economics, and public health. Comprehending the origins of garbage is crucial for formulating solutions to regulate and alleviate its impacts. Waste sources can be generically classified as residential, commercial, industrial, agricultural, building and demolition, and municipal operations. Each category generates distinct waste types and volumes, affecting the intricacy of waste management systems.