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MICROBIAL ENZYMES AND THEIR APPLICATIONS IN BIOTECHNOLOGY AND ENVIRONMENTAL PROTECTION

Miller, R. T

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Abstract: Microbial enzymes are biologically active proteins produced by bacteria, fungi, and yeasts. They are widely used in biotechnology, medicine, agriculture, food industry, and environmental protection. This study analyzes the properties and applications of microbial enzymes with special attention to bioremediation and industrial processes. The findings show that amylases, proteases, lipases, cellulases, and oxidoreductases have significant technological and ecological value.

Keywords: microbial enzymes, biotechnology, bioremediation, industrial enzymes, environmental protection

Introduction: Microorganisms are efficient producers of enzymes due to rapid growth, genetic diversity, and adaptability. Microbial enzymes offer advantages such as high catalytic efficiency, specificity, and production scalability. In environmental protection, enzymes degrade pollutants, transform toxic compounds, and support waste management. Biotechnology increasingly uses microbial enzymes as sustainable alternatives to chemical catalysts.

Materials and Methods: Scientific literature on microbial biotechnology and enzymology was analyzed. Major enzyme classes, production methods, substrate specificity, and industrial applications were reviewed. Special attention was given to environmental bioremediation and waste treatment.

Results: Amylases were widely applied in starch processing, proteases in detergent and food industries, lipases in biodiesel production, and cellulases in biomass conversion. Oxidoreductases contributed to degradation of phenolic pollutants and dyes. Microbial enzymes showed potential for eco-friendly technologies and reduction of chemical pollution.

Discussion: The use of microbial enzymes supports sustainable industrial development. Enzymatic processes require mild conditions and generate fewer toxic by-products. Challenges include enzyme stability, production cost, and optimization of activity under industrial conditions. Genetic engineering and immobilization technologies may improve enzyme efficiency.

Conclusion: Microbial enzymes are valuable tools in biotechnology and environmental protection. Their applications in industry, waste treatment, and bioremediation demonstrate significant practical importance. Future developments should focus on improving enzyme stability and large-scale production.

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