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Role of microbes in degradation of pesticides and dyes: A Review

Abstract

The extensive use of pesticides in agriculture and synthetic dyes in industries has led to widespread environmental pollution, affecting soil quality, water resources, and ecosystem stability. These pollutants are highly persistent due to their complex structures and resistance to natural degradation, while conventional treatment methods remain costly and inefficient. Microorganisms provide an eco-friendly alternative by utilizing diverse enzymatic systems to degrade, transform, or mineralize such compounds. Bacteria, fungi, and actinomycetes play a crucial role in breaking down organophosphates, chlorinated pesticides, azo dyes, and related xenobiotics into non-toxic or less harmful products. Enzymes such as laccases, peroxidases, oxygenases, and hydrolases drive these biotransformations, often resulting in complete mineralization. Microbial consortia further enhance degradation efficiency through synergistic interactions. For instance, bacterial species like Pseudomonas putida and Bacillus subtilis have been widely reported for pesticide and dye degradation, while fungi such as Phanerochaete chrysosporium and Aspergillus niger exhibit strong ligninolytic enzyme activity aiding in pollutant breakdown. Thus, microbial bioremediation offers a sustainable and cost-effective solution to pesticide and dye contamination, while advancements in genetic engineering and bioaugmentation strategies continue to improve its large-scale applicability.

Key words: Pesticides, Dyes and Microbial degradation

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