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Review

Bacterial Laccases as Biocatalysts for the Remediation of Environmental Toxic Pollutants: A Green and Eco-Friendly Approach—A Review

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Abstract: Biological treatment methods for the biodegradation of anthropogenic toxic pollutants are eco-friendly in nature and are powered by a variety of microbial enzymes. Green chemistry and enzymes play a crucial role in catalyzing the biodegradation of organic and inorganic pollutants including azo dyes; polyaromatic hydrocarbons; lead; organic cyanides; aromatic amines; mono-, di-, and polyphenols; polymers; and mercury. Laccases form a prospective group of multifunctional oxidoreductase enzymes with great potential for oxidizing different categories of organic and inorganic pollutants and their diversified functions, such as pigment formation, lignin degradation, and detoxification of industrial wastes including xenobiotics mainly from the pharmaceutical, paper textile, and petrochemical industries. Therefore, it is very important to study laccases as green and environmentally friendly alternatives for the degradation of xenobiotics. This review article will cover comprehensive information about the functions and properties of bacterial laccases for a deep understanding of their scope and applications for effective bioremediation of recalcitrant xenobiotics.

Keywords: biodegradation; laccases; oxidoreductases; green biocatalysts; xenobiotics

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1. Introduction

Laccases are the potential enzymes for oxidoreductases (a broad group of enzymes that catalyze electron transfers from one molecule to another), which are widely distributed in nature in plants, bacteria, fungi, and insects [1–3]. They are suitable for green catalysis, organic synthesis, and the biodegradation of environmental xenobiotics due to their high efficiency and sustainable applications. A wide variety of organic compounds can be oxidized by laccase, and they can be widely applied in the biodegradation of pollutants for detoxification of environments, such as delignification and pulp-bleaching, treatment of textile dyes, wastewater treatment, and treatment of other environmental xenobiotics [4–10].