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Enzyme immobilisation for the removal of xenobiotic compounds from wastewater: a laccase-focused study

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Abstract

Industrialisation, urbanisation and increasing population have resulted in the generation of a huge quantity of xenobiotic pollutants worldwide with detrimental consequences for the environment. Such compounds are recalcitrant to biodegradation, provoking their persistence and accumulation in the environment. In addition, most of them are highly toxic posing wildlife and human health at risk. Therefore, their removal from wastewater before being discharged into the environment is imperative. However, conventional wastewater treatments are ineffective in the removal of such type of compounds and emerging approaches are either expensive or non-environmentally friendly [1]. This has arisen the search for new cost-efficient and green technologies to replace or complement the conventional ones such as those based on the use of biocatalysts. In this sense, the enzyme laccase (benzenediol: oxygen oxidoreductases; EC 1.10.3.2) appears as a promising natural biocatalyst for the development of sustainable and green approaches to degrade xenobiotic compounds. Laccases belong to a group of polyphenol oxidases containing copper atoms in their catalytic centre, generally called multicopper oxidases. They reduce molecular oxygen to water in a four-electron step with the concomitant one-electron oxidation of several aromatic substrates [2]. However, the use of free laccases has several drawbacks such as poor reusability, high cost, low stability and sensibility to different denaturing agents that may be present in wastewater. Such limitations can be overcome by immobilising laccase enzymes in/on solid carriers [3]. Hence, during the last decades different approaches considering different techniques and solid carriers to immobilise laccase enzymes have been developed and tested for the removal of pollutants from wastewater.

Keywords: enzyme, immobilisation, laccase, white-rot fungus, xenobiotic

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