

## **A Brief Review of Immobilized Oxidoreductase Enzymes for the Removal of Endocrine-Disrupting Chemicals from Wastewater**

### **ABSTRACT**

Modern technological of human activities in industries or housing areas have created an unhealthy environment, particularly through unmanageable wastewater. For the time being, this kind of pollution is getting serious as it caused the emerging pollutant actively to spread to humans and living organisms. These non-biodegradable pollutants, to be specifically known as endocrine-disrupting chemicals (EDCs) are synthetic or natural chemicals that have high toxicity and persistency which can interfere with the endocrine system in humans and animals. The removal of EDCs has received high attraction among researchers using physical-chemical treatments, however, conventional techniques do not effectively remove EDCs from wastewater. This review aims to discuss research related to biological approaches that have been carried out to efficiently remove EDCs from wastewater using oxidoreductase enzymes, especially via an immobilization strategy. In general, free enzymes have limitations to be applied in industrial scales such as low stability and fragility, and unable to separate from the bulk solution. On the other hand, immobilized enzymes offer better operational stability and reusability in harsh environments. This review also discussed the bioremediation of EDCs using several immobilized oxidoreductase enzymes like lignin peroxidase (LiP), manganese peroxidases (MnP), horseradish peroxidases (HRP), laccases and tyrosinases. The application of immobilized enzymes and factors affecting the bioremediation using oxidoreductase enzymes were also explored to highlight their potential for the removal of EDCs from wastewater.