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Discovery of a novel thermophilic laccase for low-density polyethylene degradation

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PURPOSE OF THE ABSTRACT
Petroleum-derived plastics and synthetic dyes are hazardous pollutants that threaten human health and the planet's ecosystems. PE is exclusively made up by a C-C backbone without any hydrolysable groups while industrial dyes have complex aromatic structures, making both pollutants highly recalcitrant to biodegradation. [1]
Biodegradation seems to be the most attractive and eco-friendly method to combat this growing environmental problem. [2] For instance, by secreting extracellular enzymes, microbes have been identified to facilitate the functionalization and further depolymerization of PE polymers into shorter oligomers. The modified oligomers can enter the cells and can eventually be assimilated in the metabolic pathways. Enzymes involved in lignin degradation pathways, specifically laccases, have been proven to possess PE-degrading and dye-decolorizing abilities. [3] However, the discovery of new laccases to enrich the enzyme toolbox for PE and dye degradation is still valuable and should be explored further.
In the presented work, we designed a screening strategy for discovery of new enzymes that were possibly involved in pollutant-degradation pathways from reported PE-degrading microorganisms (Fig. 1). First, reported PE-eating bacteria were collected from German Collection of Microorganisms and Cell Cultures (DSMZ) and cultivated in our lab for obtaining their genomic DNA. In addition, we hypothesize that enzymes that can facilitate the functionalization and further depolymerization of PE polymers should have: (1) An open substrate-binding pocket; (2) Metal catalytic centers. According to the hypothesis, the computer-aided structure analysis was performed to identify the potential enzyme candidates. From the structural view, laccases with a relatively open catalytic pocket and copper centers are expected candidates for further investigations. After an activity-based screening of selected enzyme candidates, a novel thermophilic laccase-LfLAC3 was discovered which is applicable for the decolorization of various commercial dyes, as well as the degradation of unpretreated low-density polyethylene films.

FIGURES

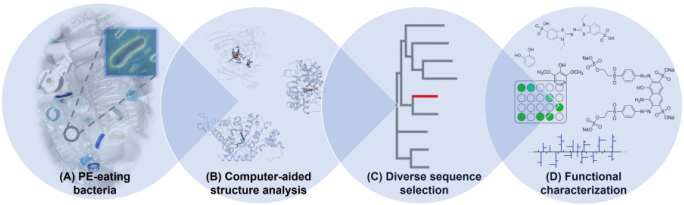

FIGURE 1

Figure 1

Strategy for discovery of new enzymes that potentially have pollutant-degrading properties.

FIGURE 2

KEYWORDS

Enzyme discovery | Laccase | PE degradation | Dye decolorization

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