BIOTRANS
LA ROCHELLE 2023

N°1520 / PC
TOPIC(s) : Synthetic biology, metabolic engineering / Enzyme discovery and engineering

Developing chassis strains for the sustainable bioconversion of lignocellulose

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PURPOSE OF THE ABSTRACT

Eighty million tons of waste lignocellulose biomass is produced each year, and it accounts for 33% of municipal waste worldwide. Therefore, utilising lignocellulose as an abundant and renewable feedstock is appealing. However, lignocellulose is composed of a complex mix of different carbohydrate-based polymers, (cellulose and hemicellulose; xyloglucan, xylan, mannan, and glucomannan) as well as the recalcitrant non-carbohydrate, alkyl-aromatic heteropolymer lignin (Figure 1). Synergistic action of multiple enzyme families, coordinating hydrolytic, non-hydrolytic and oxidative activities, is required for the degradation of these different polymers. Because of the large number of enzymes needed, it is exceedingly rare for any microorganisms to display the simultaneous ability to degrade cellulose, lignin, and hemicellulose.

The environment contains organisms that have a rich repository of enzymes with diverse functions. Accordingly, we found a novel isolate cultivated directly from lignocellulose waste, with the ability to degrade cellulose and hemicellulose. This strain had remarkable amenability to genetic manipulation, as well as reasonable metabolic flexibility. We aimed to cultivate this strain into a bona fide chassis.

This was achieved by upregulating native glycoside hydrolases, but also adding novel and well-studied enzymes from different sources, aimed at targeting the complex side chains associated with hemicellulose, namely Lytic polysaccharide monooxygenases, acetylxylan, and feruloyl esterases. We have achieved a significant improvement in the strains natural degradation efficiency and increased its substrate range.

Furthermore, we have been bio-prospecting for new lignin-degrading enzymes, such as unspecific peroxygenases (UPOs) and DyP-type peroxidases, from meta-genomic databases. After the initial characterization of these enzymes is complete we plan to improve and express them in our host strain.

FIGURES

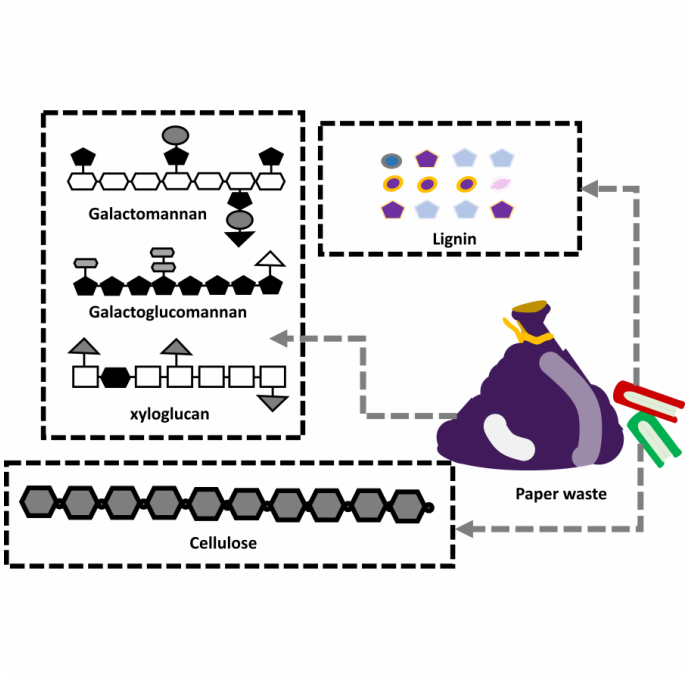

FIGURE 1

Figure 1

Representation of the complex mix of different polymers that constitute lignosellulosic waste

FIGURE 2

KEYWORDS

Unspecific peroxygenases | Glycoside hydrolases | Lytic polysaccharide monooxygenases | DyP-type peroxidases

BIBLIOGRAPHY