Structural characterization of lignin degrading enzyme PmdC, involved in the synthesis of polymer precursor 2-pyrone 4,6 dicarboxylic acid (PDC)

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Project Goals: Establish scientific knowledge & new technologies to transform the maximum amount of carbon available in bioenergy crops into biofuels and bioproducts.

Lignin is one of the most abundant materials available on earth, with 300 billion tons available globally and 20 million tons added annually providing an extensive carbon source for sustainable manufacturing of products. However, lignin remains largely under-utilized due to its tough, woody nature and inherent recalcitrance. Efficient utilization of plant biomass especially lignin, is crucial for producing biofuels to scale. Enzymatic degradation of lignin is currently an area of intense research focus as bacteria and fungi employ a variety of ligninolytic enzyme systems to breakdown lignin. The aromatics derived from lignin breakdown can serve as precursors for synthetic pathways for the production of biofuels and high value compounds such as food additives or polymers. Here, we report the protein structure of PmdC *(Comamonas)* a homolog of LigC *(Sphingomonas)*. This protein catalyzes the conversion of lignin breakdown intermediate 4-carboxy-2-hydroxymuconate-6-semialdehyde dehydrogenase (CHMS) from the protocatechuate cleavage pathway to yield 2-pyrone-4,6-dicarboxylic acid (PDC), a precursor for the synthesis of useful polymers such as polyamides, polyesters and polyurethane. Metabolic engineering efforts are already underway for creating biosynthetic routes for the synthesis of PDC in appropriate host organisms. The structure of PmdC will yield valuable insight into the mechanism of catalysis of the enzyme and will support protein engineering efforts to boost PDC production.

References:

1) Efficient production of 2-pyrone 4,6-dicarboxylic acid as a novel polymer-based material from protocatechuate by microbial function. Otsuka et al., Biotech. Products & Process Engineering 2005
2) In-planta production of the biodegradable polyester precursor 2-pyrone-4,6-dicarboxylic acid (PDC): Stacking reduced biomass recalcitrance with value-added co-product. Lin et al., Metabolic Engineering 2021

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