Lignin Biodegradation and Valorization with Synthetic Bacteria

Name

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Abstract

Lignin is the second most abundant biopolymer on earth, yet the utilization of lignin for fungible fuels and chemicals has become a bottleneck for biorefining. Some bacteria show high capacity in of aromatic compounds catabolism, like Rhodococcus opacus PD630. However, their lignin bioconversion efficiency was significantly hindered by their low lignin depolymerization capacity, where the bacteria lack efficient extracellular secreted lignin-degrading enzymes. Despite extensive research, secretory production of heterologous protein in bacteria remains highly challenging. The challenge is particularly true for the lignin degradation enzymes with high-redox potential like laccase. We hereby demonstrated that proteomics-guided engineering could enable efficient heterologous secretion with a total protein yield at 13.7g/L by balancing the processes among transcription, translation, secretion, and protein folding of ligninolytic laccase. The engineered secretory laccase in R. opacus PD630 well complemented its biochemical limits on lignin depolymerization. Further proteomics analysis revealed the key factor of efficient lipid biosynthesis for the R. opacus PD630, where a distinct multi-unit fatty acid synthase I drove the carbon partition to storage lipid. The discovery guided the design of efficient lipid conversion from lignin and carbohydrate. The integration of laccase-secretion based lignin depolymerization module and enhanced FASI lipid biosynthesis module enabled a high titer (2.54 g/L) in converting lignin-enriched biorefinery waste to lipid. The fundamental mechanisms, engineering components, and design principle could empower transformative platforms for biomanufacturing and biorefining.

Brief Biography

Prof Xie joined Huazhong University of Science and Technology as a professor in 2018. He received Ph.D degree from Texas A&M University in 2016. His research interest focuses on microbiology, synthetic biology and biorefinery, especially focus on lignin biodegradation and valorization to multiple products for bioenergy, biomedicine and biomaterial. He has published more than ten papers about lignin bioconversion in high impact journals including *Advanced Science, Green Chemistry*, *Current Opinion in Biotechnology*.

Brief CV

2018-present, Professor

College of Life Science and Technology, Huazhong University of Science & Technology, China

Education:

B.S.	Biotechnology	Huazhong University of Science & Technology, 2009
B.S.	English	Huazhong University of Science & Technology, 2009
M.S.	Microbiology	Huazhong University of Science & Technology, 2011
Ph.D.	Plant Pathology	Texas A&M University, USA, 2016

Professional Career:

10/2010-8/2016	Texas A&M University, Texas, USA, Research Assistant
8/2016-7/2018	Texas A&M University, Texas, USA, Postdoctoral Research Associate
7/2018-present	Huazhong University of Science & Technology, China, Professor

Research Interests:

1. Microbial Systems and Synthetic Biology
2. Lignocellulose biodegradation and bioconversion
3. Biosynthetic of natural products
4. Biobased polymer materials

Selected publications

1. Shangxian Xie, Su Sun, Furong Lin, et al. ***Advanced Science***, 2019, DOI:10.1002/advs.201801980.
2. Cheng Zhao, Shangxian Xie*, et al. ***Green Chemistry,*** 2016. 18, 1306-1312.
3. Shangxian Xie, Xing Qin, Yanbing Cheng, et al. ***Green Chemistry.*** 2015. 17:1657-1667.
4. Shangxian Xie, Ryan. Syrenne, et al. ***Current Opinion in Biotechnology.*** 2014. 27: 195-203.
5. Shangxian Xie, Qining Sun, et al. ***ACS Sustainable Chemistry & Engineering***. 2017. 5 (3): 2215–2223.
6. Shangxian Xie, Qiang li, et al. ***ACS Sustainable Chemistry & Engineering.*** 2017. 5 (4), pp 2817–2823
7. Su Sun, Shangxian Xie , et al. ***Scientific Reports.*** 2017. 7(1):11356
8. Su Sun, Shangxian Xie, et al. ***Journal of Hazardous Materials.*** 2016. 302, 286-295.
9. Shangxian Xie, Arthur J Ragauskas and Joshua S Yuan. ***Industrial Biotechnology.*** 2016. 12 (3):161-167
10. Shangxian Xie, Su Sun, Susie Y.Dai, et al. ***Algal Research***. 2013. 2(1): 28-33.