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**Biological cleavage of lignin bonds**

Newly discovered bacterial enzyme could help valorize lignin

**The Science**

Optimizing how we break down biomass is critical to developing valuable chemicals from renewable materials such as plant lignin. GLBRC researchers found that the bacteria *Novosphingobium aromaticivorans* rapidly breaks the β-aryl ether bond commonly found in lignin, and that its enzyme, a Nu-class glutathione *S*-transferase, performs the critical step of removing the antioxidant glutathione.

**The Impact**

Plant lignin contains aromatic compounds that, when released, could be used to make valuable and renewable commodities for the biofuel, chemical, cosmetic, food, and pharmaceutical industries. This study identifies *N. aromaticivorans* as an attractive organism for studying the β-etherase lignin degradation pathway, as well as a potential biological system for converting lignin biomass into useful commodities.

**Summary**

As a major component of plant cells walls, lignin is a potential renewable source of valuable chemicals. Several sphingomonad bacteria have been identified that can break the β-aryl ether bond connecting most phenylpropanoid units of the lignin heteropolymer. GLBRC researchers tested three sphingomonads predicted to be capable of breaking the β-aryl ether bond of the dimeric compound guaiacylglycerol-β-guiacyl ether (GGE) and found that *Novosphingobium aromaticivorans* metabolizes GGE at one of the fastest rates thus far reported. Results from this study indicate that the Nu-class glutathione *S*-transferase NaGSTNu is the only enzyme needed for the necessary step of removing glutathione from both (*R*)- and (*S*)-β-glutathionyl-γ-hydroxypropiovanillone (GS-HPV) in *N. aromaticivorans*. Researchers also solved the crystal structure of NaGSTNu and used molecular modeling to propose a mechanism for the glutathione lyase (deglutathionylation) reaction in which an enzyme-stabilized glutathione thiolate attacks the thioether bond of GS-HPV, and the reaction proceeds through an enzyme-stabilized enolate intermediate. Finally, this research revealed that Nu-class GSTs from *Sphingobium*sp. SYK-6 (which can also break the β-aryl ether bond) and *Escherichia coli*(which cannot break the β-aryl ether bond) can also cleave (*R*)- and (*S*)-GS HPV, suggesting that glutathione lyase activity may be common throughout this widespread but largely uncharacterized class of glutathione *S*-transferases. Understanding this bacterial pathway for breaking lignin bonds can aid future efforts to develop microbial systems for converting lignocellulosic biomass into commodities. A recently published companion study [Gall, *et al.* AEM (2018) DOI: 10.1128/AEM.02076-17] also demonstrated that this enzyme makes it possible to develop a complete *in vitro* enzymatic system for breaking the β-aryl ether bond of plant lignin.

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**Publications**

Kontur, W. S. *et al.* “*Novosphingobium aromaticivorans* uses a Nu-class glutathione *S*-transferase as a glutathione lyase in breaking the β-aryl ether bond of lignin.” *Journal of Biological Chemistry* **293**, 4955-4968 (2018) [DOI: 10.1074/jbc.RA117.001268].

**Related Links**

<http://www.jbc.org/content/293/14/4955.full?sid=7ff2b3f2-808e-413b-a644-d9e9b622fd49>

**PM Recommendation for SC Web Publication**