20 April 2017

**Fungus-cultivating termites exhibit strikingly rapid and efficient degradation of woody biomass**

Lignocellulose pretreatment in a fungus-cultivating termite symbiotic system*.*

**The Science**

Depolymerizing lignin, the complex phenolic polymer fortifying plant cell walls, is challenging, making lignin a major barrier to gaining access to stored energy in lignocellulosic materials. Here we reveal unprecedentedly rapid lignin depolymerization and degradation in an ancient fungus-cultivating termite system; we combine laboratory-feeding experiments with step-wise structural and chemical analyses performed while the woody material is digested in this symbiotic system.

**The Impact**

In the fungus-cultivating termite symbiotic system, lignin depolymerization takes place during the rapid passage through the pH-neutral gut of young worker termites. Striking in its speed and efficiency, the process destroys the traditionally-considered most recalcitrant C–C-bonded lignin structural units, thereby facilitating efficient degradation of the polysaccharide substrate by processes subsequently occurring via the fungus-comb microbiome. Thus, natural systems for lignin degradation/pretreatment are far beyond what was previously recognized and are potential sources of novel ligninolytic agents, enabling more efficient plant cell wall utilization.

**Summary**

Depolymerizing lignin, the complex phenolic polymer fortifying plant cell walls, is an essential but most challenging starting point for the lignocellulosics industries. The variety of ether and carbon-carbon interunit linkages produced via radical coupling during lignification limit chemical and biological depolymerization efficiency. In an ancient fungus-cultivating termite system, we reveal unprecedentedly rapid lignin depolymerization and degradation by combining laboratory feeding experiments, lignocellulosic compositional measurements, electron microscopy, 2D-NMR, and thermochemolysis. In a gut transit time of under 3.5 hours, in young worker termites, poplar lignin sidechains are extensively cleaved and the polymer is significantly depleted, leaving a residue almost completely devoid of various condensed units that are traditionally recognized to be the most recalcitrant. Subsequently, the fungus-comb microbiome preferentially utilizes xylose and cleaves polysaccharides, thus facilitating final utilization of easily digestible oligosaccharides by old worker termites. This complementary symbiotic pretreatment process in the fungus-growing termite symbiosis reveals a previously unappreciated natural system for efficient lignocellulose degradation.

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**Funding**

This study was funded by the National Natural Science Foundation of China (project 31170611 and project 31500528), Zhejiang Provincial Natural Science Foundation (project Z3100211), and by the DOE Great Lakes Bioenergy Research Center (DOE BER Office of Science DE-FC02-07ER64494).

**Publications**

Li, H. *et al.* “Lignocellulosic pretreatment in a fungus-cultivating termite**.”** *Proc. Natl. Acad. Sci. USA* (2017) [DOI: 10.1073/pnas.1618360114].

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