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Energy balance associated with the degradation of lignocellulosic material by white-rot and brown-rot fungi.

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Forest soils cover about 30% of terrestrial area and comprise between 50 and 80% of the global stock of soil organic carbon (SOC). The major precursor for this forest SOC is lignocellulosic material, which is made of polysaccharides and lignin. Lignin has traditionally been considered as a recalcitrant polymer that hinders access to the much more labile structural polysaccharides. This view appears to be partly incorrect from a microbiology perspective yet, as substrate alteration depends on the metabolic potential of decomposers.
In forest ecosystems the wood-rotting Basidiomycota fungi have developed two different strategies to attack the structure of lignin and gain access to structural polysaccharides. White-rot fungi degrade all components of plant cell walls, including lignin, using enzymatic systems. Brown-rot fungi do not remove lignin. They generate oxygen-derived free radicals, such as the hydroxyl radical produced by the Fenton reaction, that disrupt the lignin polymer and depolymerize polysaccharides which then diffuse out to where the enzymes are located
The objective of this study was to develop a model to investigate whether the lignin relative persistence could be related to the energetic advantage of brown-rot degradative pathway in comparison to white-rot degradative pathway.
The model simulates the changes in substrate composition over time, and determines the energy gained from the conversion of the lost substrate into CO_2. The energy cost for the production of enzymes involved in substrate alteration is assessed using information derived from genome and secretome analysis. For brown-rot fungus specifically, the energy cost related to the production of OH radicals is also included.

The model was run, using data from the literature on populous wood degradation by Trametes versicolor, a white-rot fungus, and Gloeophyllum trabeum, a brown-rot fungus. It demonstrates that the brown-rot fungus (Gloeophyllum trabeum) was more efficient than the white-rot fungus (Trametes versicolor). The energy advantage could explain the emergence of the brown-rot degradative pathway from a white-rot degradative pathway and subsequently, the relative persistence of lignin in soil.