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Title: Fast solubilization of recalcitrant cellulosic biomass by the basidiomycete fungus Laetisaria arvalis involves successive secretion of oxidative and hydrolytic enzymes

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Abstract: Background: Enzymatic breakdown of lignocellulosic biomass is a known bottleneck for the production of high-value molecules and biofuels from renewable sources. Filamentous fungi are the predominant natural source of enzymes acting on lignocellulose. We describe the extraordinary cellulose-deconstructing capacity of the basidiomycete Laetisaria arvalis, a soil-inhabiting fungus.

Results: The L. arvalis strain displayed the capacity to grow on wheat straw as the sole carbon source and to fully digest cellulose filter paper. The cellulolytic activity exhibited in the secretomes of L. arvalis was up to 7.5 times higher than that of a reference Trichoderma reesei industrial strain, resulting in a significant improvement of the glucose release from steam-exploded wheat straw. Global transcriptome and secretome analyses revealed that L. arvalis produces a unique repertoire of carbohydrate-active enzymes in the fungal taxa, including a complete set of enzymes acting on cellulose. Temporal analyses of secretomes indicated that the unusual degradation efficiency of L. arvalis relies on its early response to the carbon source, and on the finely tuned sequential secretion of several lytic polysaccharide monooxygenases and hydrolytic enzymes targeting cellulose.

Conclusions: The present study illustrates the adaptation of a litter-rot fungus to the rapid breakdown of recalcitrant plant biomass. The cellulolytic capabilities of this basidiomycete fungus result from the rapid, selective and successive secretion of oxidative and hydrolytic enzymes. These enzymes expressed at critical times during biomass degradation may inspire the design of improved enzyme cocktails for the conversion of plant cell wall resources into fermentable sugars.

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