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Acido-thermotolerant fungi from Boiling Springs Lake, LVNP: Potential for lignocellulosic biofuels

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Abstract

Acidic geothermal environments such as those in Lassen Volcanic National Park (LVNP) may provide novel organisms and enzymes for conversion of plant lignocellulose into ethanol, a process that typically requires hot and acidic pre-treatment conditions to hydrolyze cell wall polysaccharides to fermentable sugars. We evaluated seven Ascomycete fungi associated with LVNP's Boiling Springs Lake (BSL) for utilization of lignocellulose material. We screened the fungi for growth pH and temperature optima, and for growth on purified or natural plant cell wall components. We also examined potential lignin degradation using a (per)oxidase assay, and screened for the presence of potential (hemi)cellulose degradation genes with PCR. Growth analysis showed *Acidomyces* and *Ochroconis* grew best at 35–45 °C and pH < 4, and grew up to 48–53 °C. In contrast, *Aspergillus*, *Paecilomyces*, and *Penicillium* preferred cooler temperatures for acidic media (25–35 °C), but grew up to 48 °C. *Phialophora* only grew up to 27 °C under both acidic and neutral conditions, and *Cladosporium* showed a preference for cool, neutral conditions. The most promising material utilizers, *Acidomyces*, *Ochroconis*, and *Paecilomyces,* used cellobiose and xylan, as well as pine and incense cedar needles, for growth at 40 °C and pH 2. *Acidomyces* and *Ochroconis* showed extracellular (per)oxidase activity at 40 °C and pH 2, and PCR screening showed *Acidomyces*, *Paecilomyces*, and *Ochroconis* contain orthologs to known fungal lignocellulose degradation genes, including glucanases and xylanases. We conclude that the BSL-adapted taxa *Acidomyces*, *Ochroconis*, and *Paecilomyces* may be promising sources of enzymes that combine heat- and acid-tolerance, potentially valuable in streamlining the pre-treatment of lignocellulosic biofuels.

Keywords: Fungi, ascomycetes, extremophiles, cellulosic biofuels, peroxidases, glucanases, xylanases, biotechnology, extremophiles