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Effects of temperature on extracellular hydrolase enzymes from soil microfungi

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Abstract

Soil microbes play important roles in global carbon and nutrient cycling. Soil microfungi are generally amongst the most important contributors. They produce various extracellular hydrolase enzymes that break down the complex organic molecules in the soil into simpler form. In this study, we investigated patterns of amylase and cellulase (which are responsible for breaking down starch and cellulose, respectively) relative activity (RA) on solid media at different culture temperatures in fungal strains from Arctic, Antarctic and tropical soils. Fungal isolates from all three regions were inoculated onto R2A media supplemented with starch for amylase and carboxymethylcellulose and trypan blue for cellulase screening. The isolates were then incubated at 4, 10, 15, 20, 25, 30, 35 and 40 °C and examined for activity after 5 and 10 days, for tropical and polar isolates, respectively. The data obtained indicate that the polar fungal strains exhibited similar patterns of amylase and cellulase RA. Both Arctic and Antarctic fungi showed highest RA for amylase and cellulase at 35 °C, while colony growth was maximised at 15 °C. Colony growth and RA of the polar isolates were negatively correlated suggesting that, as temperatures increase, the cells become stressed and have fewer resources available to invest in growth. Unlike polar isolates, tropical isolates did not exhibit any trend of colony growth with temperature, rather having idiosyncratic patterns in each isolate. The low enzyme production and RA levels in the tropical strains may suggest both a low ability to respond to temperature variation in their natural thermally stable tropical habitats, as well as a level of thermal stress limiting their enzyme production ability.

Keywords Amylase · Cellulase · Soil microfungi · Arctic · Antarctic · Tropical

Introduction

Soil microbes play a vital role in soil food webs and global biogeochemical cycles, including the cycling of nitrogen, carbon, phosphorus and sulphur (Addo-Bediako et al. 2000). Bacteria, fungi and archaea are important members of soil microbial communities, playing specific roles in the soil ecosystem. For instance, fungi and Gram-positive bacteria degrade complex compounds, while Gram-negative bacteria act on less complex compounds (Tveit et al. 2015). However, fungi are the dominant decomposers of soil organic matter (de Graaff et al. 2010).

In polar environments, fungi play a vital role in cellulose decomposition (Kurek et al. 2007). Fungi from Arctic soils may even continue to catalyse biogeochemical processes under snow cover, while general environmental conditions above the snow are too extreme for biological activity (Fahnestock et al. 1998; Florczak et al. 2013). Arctic permafrost soils currently store large amounts of carbon, approximately

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