



Antimicrobial properties and the influence of temperature on secondary metabolite production in cold environment soil fungi



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ABSTRACT

The Arctic and Antarctic share environmental extremes. To survive in such environments, microbes such as soil fungi need to compete with or protect themselves effectively from other soil microbiota and to obtain the often scarce nutrients available, and many use secondary metabolites to facilitate this. We therefore (i) screened for antimicrobial properties of cold-environment Arctic and Antarctic soil fungi, and (ii) identified changes in the secreted secondary metabolite profiles of a subset of these strains in response to temperature variation. A total of 40 polar soil fungal strains from King George Island, maritime Antarctic and Hornsund, Svalbard, High Arctic, were obtained from the Malaysian National Antarctic Research Centre culture collections. The plug assay technique was used to screen for antimicrobial potential against Gram-positive and Gram-negative human pathogenic bacteria (*Bacillus subtilis*, *B. cereus*, *Pseudomonas aeruginosa*, *Enterococcus faecalis* and *Escherichia coli*). About 45% of the tested fungal strains showed antimicrobial activity against at least one tested microorganism. Three fungal isolates showed good bioactivity and were subjected to secondary metabolite profiling at different temperatures (4, 10, 15 and 28 °C). We observed a range of responses in fungal metabolite production when incubated at varying temperatures, confirming an influence of environmental conditions such as temperature on the production of secondary metabolites.

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1. Introduction

Fungi are remarkable microorganisms known to produce a diverse range of compounds extracellularly, usually of low molecular weight, known as secondary metabolites (Keller et al., 2005). Often these secondary metabolites are unique to particular microbial species (Larsen et al., 2005). There is a general consensus that secondary metabolites are not essential for growth, development or reproduction, even though they are produced by many fungi (Madigan et al., 1997). Produced generally near the end of the active growth phase, these compounds are synthesized from compounds that are themselves derived from primary metabolic

pathways (Davies, 1985). Although their ecological role often remains unclear, many exhibit antifungal or antimicrobial activity (Peláez, 2006) and are therefore likely to provide the producing microorganism with a competitive advantage facilitating survival in their natural environment.

Although the systematic study of fungal secondary metabolites began in 1922 (Raistrick, 1950), it was not until the discovery of penicillin by Alexander Fleming in 1928 (Alharbi et al., 2014; Ligon, 2004a,b) that the exploration of secondary metabolites started to intensify. Over recent decades considerable efforts have been devoted to the study of these compounds. This is, in part, driven by the rapidly increasing levels of resistance towards many of the currently available antibiotics (Cooper and Shlaes, 2011).

It is widely accepted that differences in evolutionary pressures have led to some level of specificity associated with ecological niches. To date, the search for pharmaceutically-active fungal strains has largely been focussed in the temperate and tropical

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