Characterization of Inducible HSP70 Genes in an Antarctic Yeast, Glaciozyma antarctica PI12, in Response to Thermal Stress

ABSTRACT

The induction of highly conserved heat shock protein 70 (HSP70) is often related to a cellular response due to harmful stress or adverse life conditions. In this study, we determined the expression of Hsp70 genes in the Antarctic yeast, Glaciozyma antarctica, under different several thermal treatments for several exposure periods. The main aims of the present study were (1) to determine if stress-induced Hsp70 could be used to monitor the exposure of the yeast species G. antarctica to various types of thermal stress; (2) to analyze the structures of the G. antarctica HSP70 proteins using comparative modeling; and (3) to evaluate the relationship between the function and structure of HSP70 in G. antarctica. In this study, we managed to amplify and clone 2 Hsp70 genes from G. antarctica named GaHsp70-1 and GaHsp70-2. The cells of G. antarctica expressed significantly inducible Hsp70 genes after the heat and cold shock treatments. Interestingly, GaHsp70-1 showed 2–6-fold higher expression than GaHsp70-2 after the heat and cold exposure. ATP hydrolysis analysis on both G. antarctica HSP70s proved that these psychrophilic chaperones can perform activities in a wide range of temperatures, such as at 37, 25, 15, and 4 ◦C. The 3D structures of both HSP70s revealed several interesting findings, such as the substitution of a β-sheet to loop in the N-terminal ATPase binding domain and some modest residue substitutions, which gave the proteins the flexibility to function at low temperatures and retain their functional activity at ambient temperatures. In conclusion, both analyzed HSP70s played important roles in the physiological adaptation of G. antarctica.