Intracellular response of Antarctic yeast to cold stress

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Microbes growing at subzero temperatures encounter numerous growth constraints. However, fungi that inhabit cold environments can grow and decompose organic compounds at sub-zero temperatures. Thus, understanding the cold-adaptation strategies of fungi in extreme environments is critical for elucidating polar-region ecosystems.

We previously reported that *M. blollopis* strains by using CE-TOFMS. *M. blollopis* SK-4, which grew well under subzero temperatures, accumulated high levels of TCA-cycle metabolites, lactic acid, aromatic amino acids, and polyamines such as spermine and spermidine in response to cold shock[1)].

In the model organism *Saccharomyces cerevisiae*, increased accumulation of polyamines such as spermine and spermidine, and *S*-adenosylmethionine (SAM), an intermediate in polyamine synthesis, enhances low-temperature growth.

SAM is the link between polyamines and methionine metabolism. In model organisms such as *S. cerevisiae* and *Caenorhabditis elegans*, exposure to cold stress leads to an elevation in the production of SAM, consequently resulting in an increased buildup of the methionine metabolite *S*-adenosylhomocysteine (SAH). In *S. cerevisiae* and *C. elegans*, the buildup of *S*-adenosylhomocysteine (SAH) as a consequence of cold stress triggers an inhibition of methionine synthesis. This inhibition of methionine synthesis leads to a reduction in the activity of TORC1 (Target of Rapamycin Complex 1), a crucial cellular pathway associated with growth and metabolism regulation.

The downregulation of TORC1 activity subsequently promotes the activation of autophagy, a cellular process responsible for recycling and degradation of cellular components. Additionally, this reduction in TORC1 activity also leads to the activation of AMPK (AMP-activated protein kinase), specifically the *snf1* homolog in yeast, which serves as an energy sensor and regulator of cellular metabolism[2)].

The collective effect of these molecular responses, including increased autophagy and AMPK activation, contributes to the extension of lifespan observed in these organisms under low temperature stress conditions.

In this study, we employed *Mrakia blollopis,* the prevailing fungal species found in the Syowa Station, Antarctica, to investigate alterations in gene expression and metabolite accumulation in response to the cold stress induced by sub-zero temperatures. This examination was conducted through the utilization of transcriptomic and metabolomic analyses.

In this presentation, we will introduce the changes in polyamine and methionine metabolic pathways induced by cold stress in *Mrakia blollopis*.

REFERENCES

1) M. Tsuji. R. Soc. Open Sci. 3, 160106 (2016).

2) T. Ogawa et al.: Aging Cell, 21, e13604 (2022).