Genomic aspects of thermotolerance of mesophilic microorganisms

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Abstract

High-temperature fermentation is expected to be one of next generation technologies due to its several advantages including reduction of cooling cost and prevention of contamination during fermentation process. Thermotolerant microbes are key components in the new technology. We thus focus on the molecular mechanism supporting survival at a critical high temperature (CHT) in three thermotolerant mesophiles, *Escherichia coli*, *Acetobacter tropicalis* and *Zymomonas mobilis.* Genome-wide screening with a single-gene knockout library or transposon-inserted library provided a list of genes indispensable for growth at a CHT, called thermotolerant genes. These genes can be functionally classified into 9 categories. In addition, we performed thermal adaptation of two species and three strains of mesophiles for improvement of the survival upper limit of temperature, and the improvement was evaluated by a newly developed method. To understand the limitation and variation of thermal adaptation, experiments with mutators and by multiple cultures were performed. The results suggest that these microbes bear a genomic potential to endure a 2-3˚C rise in temperature but possess a limited variation of strategies for thermal adaptation. These studies reveal the molecular mechanism of thermotolerance or strategy for its survival at CHT. This knowledge may allow us to generate further thermotolerant microbes or to convert non-thermotolerant to thermotolerant mesophile.

Brief Biography

Prof. Mamoru Yamada was the Director of Science Research Center, 2009-2012 and the Dean of Faculty of Agriculture, 2012-2016, Yamaguchi University. He has been appointed as the Director of Research Center for Thermotolerant Microbial Resources in the same University, 2019. He has published more than 130 SCI papers and received 3 items of awards. He organized or is organizing international joint research programs as a coordinator at Japan side, including the Asian Core Program, 2008-2012, Asian Science & Technology Strategic Cooperation Promotion Program, 2010-2012, Core to Core Program, 2014-2018 and e-ASIA Joint Research Program, 2017-2019.

Brief CV

Mamoru Yamada, Ph.D.

Graduate School of Science and Technology for Innovation, Yamaguchi University, Yamaguchi

Education:

B.S Agricultural Chemistry in Undergraduate Course, Yamaguchi University, 1978

M.S Agricultural Chemistry in Graduate Course, Yamaguchi University, 1980

Ph.D. Biochemistry in Graduate Course of School of Medicine, Yamaguchi University, 1984

Professional Career:

1984-1985 Assistant Professor, School of Medicine, Yamaguchi University

1985-1987 Postdoctoral Researcher, Biology, California University at San Diego

1897-1900 Assistant Professor, School of Medicine, Yamaguchi University

1990-2001 Associate Professor, Faculty of Agriculture, Yamaguchi University

2001-2004 Professor, Faculty of Agriculture, Yamaguchi University

2004-2016 Professor, Graduate School of Medicine, Yamaguchi University

2016-Present Professor, Graduate School of Science and Technology for Innovation, Yamaguchi University

Research Interests:

1. Bacterial thermotolerance
2. High-temperature fermentation
3. Survival at a long-term stationary phase

Selected publications

MIG1 as a positive regulator for the histidine biosynthesis pathway and as a global regulator in thermotolerant yeast *Kluyveromyces marxianus*, *Scientific Reports*, doi: 10.1038/s41598-019-46411-5 (2019)

Capacity for survival in global warming: Adaptation of mesophiles to the temperature upper limit. *PLoS ONE*, doi: 10.1371/journal.pone.0215614 (2019)

Functional analysis of Mig1 and Rag5 as expressional regulators in thermotolerant yeast *Kluyveromyces marxianus. Appl. Microbiol. Biotechnol.*, DOI:10.1007/s00253-018-9462-y (2018)

Update of thermotolerant genes essential for survival at a critical high temperature in *Escherichia coli. PLoS ONE*, doi.org/10.1371/journal.pone.0189487 (2018)

Thermotolerant genes essential for survival at a critical high temperature in thermotolerant ethanologenic *Zymomonas mobilis* TISTR 548. *Biotechnol Biofuels*, 10:204. doi: 10.1186/s13068-017-0891-0 (2017)