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How has sake yeast acquired high fermentation ability?

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Purpose: Sake yeast strains that belong to the budding yeast *Saccharomyces cerevisiae* exhibit higher rates of alcoholic fermentation and ethanol yields in the sake mash than the other types of *S. cerevsiae* strains. Although this has traditionally been regarded to be caused by their higher resistance against ethanol and various environmental stresses, our recent studies revealed that they are rather defective in stress responses.

Results: Our genomic and transcriptomic approaches have led to the identification of the sake yeast-specific loss-of-function mutations in the RIM15 gene, which encodes a Greatwall-family protein kinase that plays important roles in the responses to environmental changes. Surprisingly, this mutation markedly contributed to the increase of alcoholic fermentation rate. Furthermore, we successfully revealed the mechanism how the impaired Rim15p functions enhanced alcoholic fermentation. In response to stresses, Rim15p activates downstream transcriptional factors Msn2p and Msn4p (Msn2/4p) and Hsf1p, which upregulate the UGP1 gene that encodes UDP-glucose pyrophosphorylase. Enhanced UDP-glucose synthesis diversifies the intracellular glucose flux from glycolysis to the storage and structural carbohydrates anabolic pathways. Dysfunction of Rim15p leads to maintenance of the high fermentation performance and defective synthesis of carbohydrates to protect themselves even under the stressful environments.

Conclusions: Thus, we first reported the causal mutations for the high alcoholic fermentation ability of the industrial yeast strains. These findings have drastically changed how we understand the relationship between ethanol tolerance and ethanol production ability of yeast cells. Moreover, application of our finding is promising in improvement of the fermentation performance of other yeast strains used in various kinds of fermentation industries, such as food, brewing, and biofuel industries.