Student Research Lab

Understanding of priming and memory responses in filamentous fungi using vibrational spectroscopy and data modelling

This page contains a description of a student research lab project. To read more about the student research lab concept, go to the full description.

Introduction:

In psychology, priming could be defined as a *mental shortcut* in which a previous stimulus with an active conscience response, leads to a response without conscious guidance or intention in a subsequent and similar stimulus. Therefore, the response to the second stimulus is much faster due to the first experience.

In microbiology, **priming** is defined as the ability of a microorganism to improve or modify its performance in a stress-triggering event after being exposed to similar stress but at milder conditions (Rilling et al. 2015). It is postulated that priming is related to epigenetic changes, such as gene activators or repressors, histone relaxation, DNA methylation, etc., leading to a physiological change in the cell (Hilker et al. 2015). Several studies have reported priming in bacteria (Lambert and Kusell 2015) and yeast (Guan et al., 2012). However, priming in filamentous fungi is understudied, although a couple of studies have reported priming under temperature-based stress for several soil filamentous fungi (Andrade-Linares et al. 2016a; Szymczak et al. 2020).

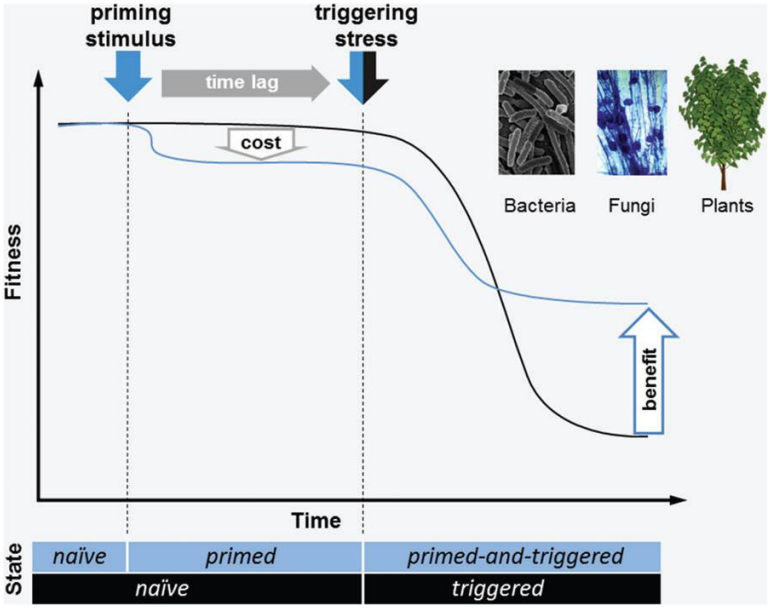

Figure 1. Graphical explanation of priming and fitness performance. Bacteria, fungi and plants were reported as organisms without nervous system that possess priming. The exposition to a stimulus at mild conditions promotes a priming effect (blue line) where the organism spend energy in its adaptation. Subsequently, the

organism with priming stimulus (blue line) performs better when a triggering event is applied (difference between blue and black line). Retrieved from Hilker et al. (2015)

Nevertheless, the cellular physiological changes leading to priming and change in the performance at stress-triggering conditions were not deeply evaluated. The authors just indicated several possible alterations like a higher synthesis of trehalose, membrane fluidity modification or increase of heat-shock proteins (e.g., chaperones). Vibrational spectroscopy methods like FT-IR or Raman can be useful tools to assess these physiological changes, since increase/decrease of several components are evaluated simultaneously.

Temperature priming could be considered an interesting feature in fermentation processes that requires stages at different temperatures. To give an instance, processes like non-isothermal simultaneous saccharification and fermentation (NSSF) in which a first step at high temperature (40-50°C) is applied for optimal enzymatic conversion of cellulose to glucose followed by a stage of optimal temperature for fungus growth (25-35°C). Temperature priming would allow a faster growth of the fungi during the first step (40-50°C) making the process faster.

Example of research tasks:

The student will learn basic methods of fungi cultivation and evaluation of growth rates. Examination of growth rates at different temperatures with or without previous stimulus will be employed to assess priming and memory responses in a set of *Mucoromycota* fungi (fig. 2 left shows an example of the approach to be followed). Biomass composition will be evaluated with FT-IR and Raman to determine the physiological changes involved in the priming ability (fig. 2 right). Strains with temperature-triggered priming will be evaluated for its use in fermentation processes for lipid production.

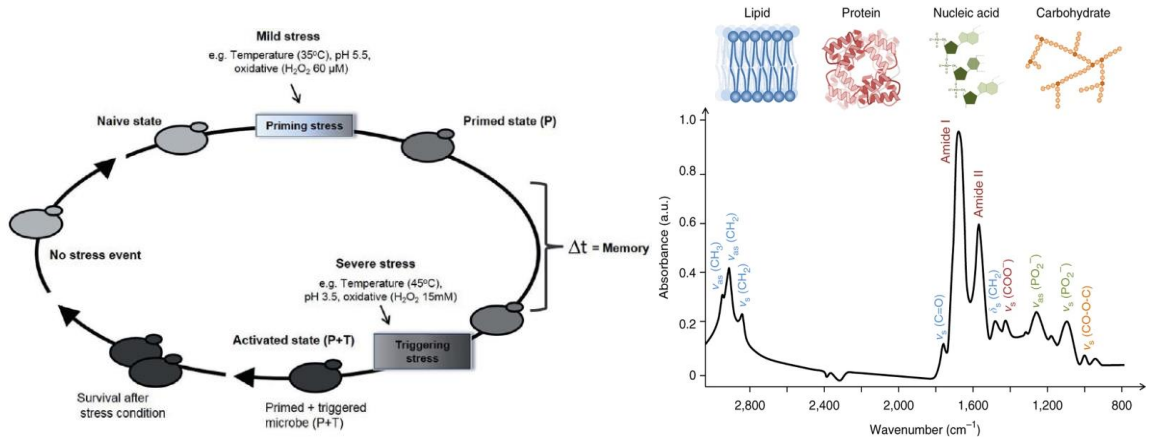

Figure 2. Left) Scheme of priming yeast at mild temperature (35°C) before a triggering stress (45°C) and memory. Retrieved from Andrade-Linares (2016b). Right) evaluation of different components of biomass using FT-IR spectroscopy. Retrieved from Baker et al. (2014).

Methods:

- Performance of growth rate measurements in fungi with solid and liquid media
- FT-IR and Raman on biomass fungi samples.
- Enzymatic activity with spectrophotometric methods.

Literature:

Andrade-Linares, D. R., Lehmann, A., and Rillig, M. C. (2016b). Microbial stress priming: A meta-analysis. Environmental Microbiology, 18(4), 1277–1288. https://doi.org/10.1111/1462-2920.13223.

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