Modification of *Saccharomyces cerevisiae* fermentative metabolism by application of electric currents to fermentation medium

Tizei, PAG[1]; Carazzolle, MF[1]; Argueso, JL[2]; Pereira, GAG[1]*
1 - Universidade Estadual de Campinas – Campinas, SP - Brasil. 2 – Colorado State University – Fort Collins, CO - USA
*Corresponding author: goncalo@unicamp.br

The search for alternative energy sources has motivated efforts to increase the efficiency of ethanol production from biomass-derived sugars. One field which is still poorly studied is the use of bioelectric reactors to alter microbial metabolism and optimize the production of desired compounds. Bioelectric stimulation involves the use of electrodes and external power sources to deliver electric currents into fermentation media, transferring electrons between the cells and external electric circuits. While these systems are widely researched for the culture of bacteria, only a few studies with *Saccharomyces cerevisiae* have been done. These showed increases in ethanol productivity, but did not investigate the mechanisms responsible for the response to bioelectric stimulation.

Bioelectrically-stimulated fermentations conducted in our laboratory with *S. cerevisiae* S288c had volumetric ethanol productivities up to 5% higher than unstimulated controls and similar increases in substrate consumption rate. In addition to the effect on rate of production of ethanol, final byproduct concentrations were strongly affected by the electric currents. The ratio of acetic acid to glycerol at the end of fermentations under electric stimulus were up to twice as high as controls, which suggests a strong effect on the redox balance of yeast metabolism. Control experiments with electric current applied to cell-free culture medium demonstrate that a purely electrochemical effect cannot explain the observed changes.

Global gene expression profiling will be carried out by RNA-Seq on samples collected during control and bioelectrically-stimulated fermentations by *S. cerevisiae*. Both data sets will be compared to determine putative genes involved in the response to bioelectric and to elucidate the mechanism by which yeast cells respond to this culture condition, enabling future genetic modification with the aim of optimizing bioelectric fermentations.

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