Effects of static magnetic field in *Saccharomyces cerevisiae* cultures under aerobic and anaerobic conditions

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Magnetic fields have been studied by many researchers as an agent that provides changes in the metabolism of microorganisms. The effects in biological systems are produced by a relative movement between mobile ions or intracellular free electrons and the magnetic field, which can generate electric fields within a cell. Despite of the interaction mechanism to be yet unclear, is known also that the direct action of magnetism cause changes in the conformational shape of cell proteins, altering its functions.

The purpose of this research was to investigate whether static magnetic field (SMF) could be applied to increasing ethanol yield by *S. cerevisiae* and verifying the biological effects on growth stimulation or inhibition. The influence of aerobic and anaerobic conditions and the ability of the cells to induce their defensive enzymes were also explored.

Batch fermentations of *S. cerevisiae* were conducted for 26 h, in YPD medium, in hyperbaric bioreactor (Parr 4563, Parr Instruments, USA) with 5 NdFeB magnets, with an average flux of 120 mT (measured by a PHYWI Teslameter, USA). The magnets were enclosed into a transparent flat polyethylene case with 4.0 x 3.5 cm and 1.3 cm width. All magnets were disposed with the same polarity, so when closed the case every one showed similar north or south poles at each face of the case. As they repelled each one, the magnets maintained the maximal distance between them, in an "X" disposition, with a magnet in the center. Controls were performed in the same manner without magnets. To investigate the effects of gas, aerobic and anaerobic conditions trials were performed under air (1 bar and 5 bar) and nitrogen (1 bar).

An increase of the cell dry weight and specific growth rate, under aerobic conditions (5 bar of total air pressure), of approximately 2-fold was obtained compared with the experiments exposed to nitrogen, for both magnetized and non-magnetized cultures. The cellular growth was not stimulated by the application of SMF. In fact, an improvement of 2-fold in specific growth rate was obtained in the control group, for aerobic and anaerobic conditions.

An increase of approximately 3-fold in biomass yield was obtained in aerobic cultures compared with anaerobic. The biomass yield of exposed group to SMF was similar to non-exposed one under 5 bar of air pressure and in nitrogen cultures. On the other hand, a stimulation of ethanol production was obtained in magnetized cultures relatively to those of the controls, for both aerobic and anaerobic conditions.

Generally, antioxidant enzymes were induced by total air. An increase of the SOD specific activity in magnetized cultures was obtained compared with the control experiments. Also, the SMF exposed cultures reached the highest values of the catalase specific activity. However, SMF exposure led to a decrease in the glutathione reductase activity.

The marker malondialdehyde (MDA) is certainly the most widely used to assess the lipid peroxidation processes. The use of anaerobic conditions resulted in a reduction of MDA levels, for both exposed and nonexposed groups. Generally, the MDA concentration was similar for both magnetized and nonmagnetized cultures.

This work shows that magnetic fields can be applied as a controlling factor of *S. cerevisiae* fermentations for ethanol or enzymes production.

Keywords: static magnetic field (SMF), *Saccharomyces cerevisiae*, aerobic and anaerobic conditions, ethanol.