Analysis of Light Absorbance on the Effects of Low Frequency Magnetic Fields on Cell Proliferation

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Abstract— An experiment to measure the effects of low frequency magnetic fields on cell proliferation was performed. Magnetic fields of low amplitudes, ranging from 1 to 4 mT, at frequencies of 60, 100, 800, 1500 and 2450 Hz were used to stimulate cell cultures of yeast Saccharomyces cerevisiae. The stimulation was carried out during 5 minutes, with intervals of 5 minutes rest, for 8 hours. A control and an experimental sample were measured two times for each frequency at the beginning of the experiment and at 2, 4, 6 and 8 hours later. In each measurement series a new cell culture was prepared for both non-stimulated and stimulated samples. The cells were grown in a liquid medium composed by 0.3 g yeast extract, 1.0 g gelatin peptone and 2.0 g dextrose for 100 ml solution of growth medium, with pH adjusted to 4.5 with NaOH. Measurements of cell proliferation were based on light absorbance using a Beckman DU-650 spectrophotometer at 600 nm wavelength. A comparison of growth rate showed an increasing of cell proliferation in stimulated cells compared to the non-stimulated ones, with differences from 8% to 16% after 8 hours of exposure, for most of the frequencies employed, except at 60 and 800 Hz, where the control sample showed an increasing larger than the stimulated cultures, particularly at the final of the experiment. For the first hours of the experiments the results are variable, coming to present a clear trend only after 4 hours. In conclusion, the results of this experiment show an influence of magnetic fields on cell evolution, which is a function of both the exposure time and the stimulation frequency.

1. INTRODUCTION

The understanding of the effects of low frequency electromagnetic fields on biological systems is still an open problem. A large number of cell cultures have been studied and reported in the literature. Studies performed using different stimulation parameters, such as intensity of the magnetic field, frequency of the signal and exposition time have been published, with often contradictory results. One biological model widely used in many experiments uses yeast Saccharomyces cerevisiae, because of their non-pathogenic nature for human beings, as also the possibility of working at room temperature.

Alterations in gene expression produced by 60 Hz AC magnetic fields on Saccharomyces cerevisiae were reported by Binninger and Ungvichian [1]. They found changes in the abundance of messenger RNAs after a continuous exposure to 20 μT 60 Hz AC electromagnetic fields. Weisbrot [2] measured transcript levels for gene in Saccharomyces cerevisiae following exposures to a 60 Hz continuous wave sinusoidal field at various field strengths and exposure times. Moreover, proliferation response of yeast saccaromyces cerevisiae on electromagnetic field has been studied by several researchers [3–5], employing 50 and 60 Hz magnetic fields, with somewhat contradictory results. More recently Ruiz-Gómez et al. [6] published a new work where they report that a 2.45 mT, sinusoidal 50 Hz magnetic field induces alteration in the growth and survival of saccaromyces cerevisiae, but not induce alterations in the cell cycle and does not cause DNA damage.

In the same way, Anton-Leberre and colleagues [7] have published a study of the effects of strong static (up to 16 T) and pulsed (up to 55 T single-shot and 4×20 T repeated shots) magnetic fields on *Saccharomyces cerevisiae* cultures. They examined gene expression, proteome profile, cell viability, morphology, and growth after magnetic field exposure. They found no effects of the magnetic field on these cellular processes.

In this paper a study conducted on cell cultures of yeast Saccharomyces cerevisiae using magnetic fields of low amplitudes, ranging from 1 to 4 mT, at frequencies of 60, 100, 800, 1500 and 2450 Hz is reported.

2. MATERIAL AND METHODS

Cell cultures were grown in an YPD medium composed by 0.3 g yeast extract, 1.0 g gelatin peptone and 2.0 g dextrose for 100 ml solution of growth medium. The pH was adjusted to 4.5 with NaOH. In each experiment were inoculated 100 µl of Saccharomyces cerevisiae culture in 1.2 ml YPD medium. The culture was grown at 28°C.

A Rodin coil system was assembled with two identical coils 2.2 cm diameter and 21 turns, arranged in series, with a total electrical resistance $R = 6.83\,\Omega$.

The samples were placed in vials and stimulated during 8 hours at intervals of 5 minutes exposition and 5 minutes rest. Frequencies of 60, 100, 800, 1500 and 2450 Hz were used for stimulation.

To determine the cell proliferation the light absorbance of cell cultures was measured every 2 hours with a Beckman DU-650 spectrophotometer (American Laboratory Trading, Inc., San Diego, CA, USA) at 600 nm wavelengths. Each measurement was repeated 12 times in order to estimate the uncertainty.

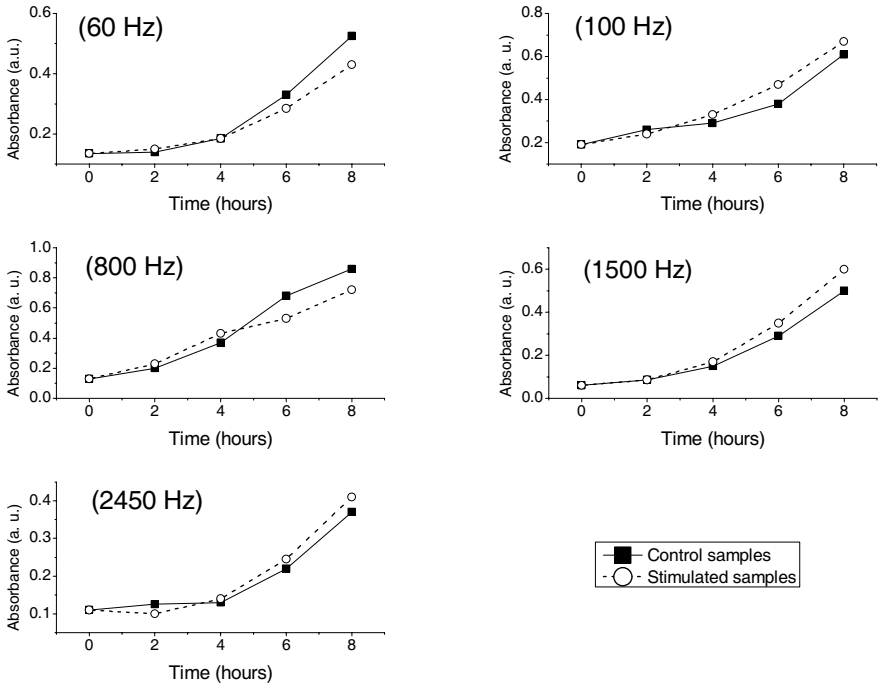

Figure 1: Growth rates for five stimulated samples at different frequencies and their comparison with the control ones.

3. RESULTS AND DISCUSSION

A comparison between a control and an experimental sample was performed in order to assess the influence of low frequency magnetic fields on Saccharomyces cerevisiae cell proliferation. In Figure 1 are shown the results for measurements performed at frequencies of 60, 100, 800, 1500 and 2450 Hz. In each case five evaluations of cell proliferation were determined at 0, 2, 4, 6 and 8 hours after starting the experiment.

The analysis of curves in Figure 1 show a growth rate increasing in stimulated cells compared to the non-stimulated ones, with differences from 8% to 16% after 8 hours of exposure, when frequencies of 100, 1500 and 2450 Hz were employed. On the contrary, at 60 and 800 Hz the control sample showed an increasing larger than the stimulated cultures, particularly at the final of the experiments. In all cases, for the first hours of the experiments the results were variable, coming to show a clear trend only after 4 hours.

4. CONCLUSIONS

The results of this experiment show an influence of magnetic fields on Saccharomyces cerevisiae cell proliferation, which is a function of both the exposure time and the stimulation frequency.

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