DEVELOPMENT OF AN EXPERIMENTAL PLATFORM FOR THE MEASUREMENT OF LOW-FREQUENCY MAGNETIC FIELD EFFECT ON YEAST CELLS

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Introduction

This contribution presents the development of an innovative experimental platform to investigate the effect of low-frequency (LF) magnetic fields (MF) on biological structures. Impedance spectroscopy is one of the available methods for concentration estimation during culture growth. The research is focused on the development of a methodology based on impedance measurement for the characterization of low-frequency magnetic field effects on living cells which could potentially find applications in diagnostic and therapeutic.

Material and Methods

One way to determine the impact of LF MF on cells is to compare the concentration of cell samples after cultivation. Concentration estimation based on electrical impedance spectroscopy is one of the essential methods. Because cells in the medium can be modeled as an equivalent circuit consisting of capacitors and resistors, their growth can be expressed by the changes in electrical impedance. Estimated cell concentration can be acquired by applying a proper estimation approach to the obtained impedance spectra. One of the approaches for estimation of the cell concentration N_c was proposed by K. Asami & T. Yonezawa [1]. This technique has been proven to be useful for monitoring cell concentration through the following formula: $N_c = \frac{\varepsilon_0}{3\pi r^4 C_m} \cdot \frac{\Delta\varepsilon(t,f)}{F(t,f)}$ where N_c is the number of cells per unit volume, C_m is the membrane capacitance regarded as a constant (about 1 μF/cm^2), r is the radius of the cell shell-sphere (about $2 \cdot 10^{-6}$ m), ε_0 is the permittivity of vacuum, $\Delta\varepsilon$ shows the change in permittivity of the sample at two different times $\Delta\varepsilon = \varepsilon_2(t_1,f) - \varepsilon_1(t_0,f)$, $F(t,f) = 1/(1 + (f/f_c(t))^2)$, f is the applied frequency, and f_c is the central frequency.

Results

The constructed experimental platform consists of five main parts: a pair of cultivation chambers, an optical microscope, a system for MF generation, an impedance spectroscopy analyzer, central control, and a data acquisition unit. Yeast *Saccharomyces cerevisiae* is used as a biological model. The cells are cultivated in yeast extract peptone dextrose medium. Starting cell concentration is approximately 2.5×10^5 cells/ml. From minute 600 of the cultivation, there is a visible sign of inhibition of the cell sample in the chamber which was exposed to MF. The ratio between the two samples reached 0.89 at its minimum, meaning the concentration of the sample which was exposed to MF is about 11% lower than the one that was placed in the chamber with the active MF.

Discussion and Conclusion

Obtained preliminary results display the promising outcome of our study, showing LF MF with specific parameters can distort the yeast cell growth curve. Such a type of distortion can generally be interpreted as inhibition or stimulation which is visible after the end of the exponential growth phase. However, more experiments must be performed in order to collect enough data for proper analysis and conclusions.

References

[1] Asami K. & Yonezawa T. (1995) Dielectric analysis of yeast cell growth, *Biochimica et Biophysica Acta* 1245, 99-105