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# Membrane Permeabilization of Pathogenic Yeast in Alternating Sub-microsecond Electromagnetic Fields in Combination with Conventional Electroporation

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## Abstract

Recently, a novel contactless treatment method based on high-power pulsed electromagnetic fields (PEMF) was proposed, which results in cell membrane permeabilization effects similar to electroporation. In this work, a new PEMF generator based on multi-stage Marx circuit topology, which is capable of delivering 3.3 T, 0.19 kV/cm sub-microsecond pulses was used to permeabilize pathogenic yeast *Candida albicans* separately and in combination with conventional square wave electroporation (8-17 kV/cm, 100  $\mu$ s). Bursts of 10, 25, and 50 PEMF pulses were used. The yeast permeabilization rate was evaluated using flow cytometric analysis and propidium iodide (PI) assay. A statistically significant ( $P < 0.05$ ) combinatorial effect of electroporation and PEMF treatment was detected. Also the PEMF treatment (3.3 T, 50 pulses) resulted in up to 21% loss of yeast viability, and a dose-dependent additive effect with pulsed electric field was observed. As expected, increase of the dB/dt and subsequently the induced electric field amplitude resulted in a detectable effect solely by PEMF, which was not achievable before for yeasts in vitro.

**Keywords:** *Candida albicans*; Dielectrophoresis; Electroporation; Magneto-permeabilization; Propidium iodide.

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