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Protonic Faraday cage effect of cell envelopes protects microorganisms from cytolysis in electrohydrodynamic structures

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An aqueous electrohydrodynamic (EHD) floating liquid bridge is a unique environment for studying the influence of protonic currents (mA cm-2) in strong DC electric fields (kV cm-1) on the behavior of microorganisms. It forms in between two beakers filled with water when high-voltage is applied to these beakers. To understand the behavior of microorganisms in the water bridge and the influence of the high electric field influence within this system on the cells three different setups were tested: Starting with cells in two beakers, starting with cells in the anode beaker and starting with cells in the cathode beaker. We recently discovered that exposure to this bridge has a stimulating effect on *Escherichia coli.* In this work we show that the survival is due to natural Faraday cage effect of the cell wall of these microorganisms using a simple 2D model. The current densities have been calculated for each cell type (depending on the starting conductivity of the cell solution) and the cells have been modeled. We further confirm this hypothesis by measuring and simulating the behavior of *Bacillus subtilis subtilis, Neochloris oleoabundans, Saccharomyces cerevisiae* and THP-1 monocytes. Cells without a natural Faraday cage like algae and monocytes are mostly killed and weakened, whereas yeast and *B. subtilis* survive. The effect of the natural Faraday cage diverts the current from passing through the cell and because it is protonic, it maintains the osmotic pressure in the cell wall, thereby mitigating cytolysis due to the low osmotic pressure of the surrounding medium.

Biography

Astrid Helga Paulitsch-Fuchs has expertise in biofilm formation of fungal and bacterial species; especially the response of organisms in those structures to antimicrobial substances. Recently she also focuses on the influence of magnetic and electric fields on the cell envelopes of different species. After completing her PhD at the University of Graz, Austria she moved to the Netherlands and worked as a Post Doctorate and Theme Coordinator at Wetsus, European Center of Expertise for Sustainable Water Technology.

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