The Study of the Dielectric Response of Red Blood Cells to Sugar Exposure – *In vitro* Basis for Non-invasive Glucose Impedance Monitoring

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Introduction: A non-invasive continuous glucose monitoring device offers the most attractive approach for patients with diabetes mellitus [1,2]. Because of the specific reactions of blood and tissue cells to varying sugar concentrations, the electrolyte balance across membranes of blood and underlying tissues is changed [3] and dielectric spectroscopy (DS) is very sensitive to such subtle changes. Here, we present *in vitro* results using DS as a non-invasive and real-time monitoring technique to study the sugar influence on dielectric properties of erythrocytes (RBCs).
Methods: The general principles of Time Domain Dielectric Spectroscopy (TDDS) and a detailed description of the experimental measurement method and procedure have been previously described [4-5]. RBCs and RBC ghosts were suspended in PBS with varying sugar concentrations and measured by TDDS. The part of the dielectric permittivity spectra, corresponding to the Maxwell-Wagner relaxation process, was fitted to the suitable biophysical cell model according to the different structural states of the cells. The volume fraction and size of the suspended RBCs were concurrently measured.
Results: A concentration-dependent membrane capacitance increase was found when RBCs were exposed to varying D-glucose and fructose concentrations. The different values of the sugar-mediated membrane polarization ofRBCs were obtained. Roles of regulative ion activity (specifically Na^+/K^+) and ATP in these processes were found as crucial.
Conclusions: DS has been shown to be a sensitive method for monitoring cellular responses on transport of sugars that differ in transport ability, kinetics and transport mediators. These results will further help to facilitate and continue the development of sensitive miniaturized tools for real-time glucose monitoring based on the characterization of the dielectric properties of tissues and blood.

References:
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