The Impact of Glucose Concentration in Blood Plasma on Relative Dielectric Constant and Conductivity

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The development of a reliable continuous glucose monitoring technology, which would lessen the complications associated with diabetes through optimal glycemic control, is a key to improving the quality of lives of patients living with the disease. In recent years, considerable progress has been made in developing implantable biosensors that can continually monitor glucose levels. These biosensors rely on the interstitial fluid within the dermis to measure the interstitial glucose (IG) levels. However, to be truly beneficial, the implanted sensor must be able to function properly for an extended period of time. The biosensors developed thus far can only remain functional up to 10 days after their implantation in the body. Contributing factors for this loss of functionality include the degradation and fouling of the sensor, and the changes in the tissue surrounding the sensor such as fibrosis and inflammation. While researchers explore potential solutions to improve the current implantable biosensors, there is a need to investigate other alternative technologies. One alternative way of predicting glucose concentration would be to use the electrical properties of blood plasma.

In this study, we investigate the effect of glucose concentration in blood plasma on electrical properties, ε and σ. The measurements were performed on 10 blood plasma samples collected from healthy individuals between the ages of 18 and 40 at UAB Children's Hospital of Alabama. Agilent's 85070D high-temperature dielectric probe kit and an E8362B PNA network analyzer was used for measurements between 200 MHz and 20 GHz. Although the changes in ε were not significant for various glucose concentrations, the changes in σ, especially at higher frequencies, suggest that the microwave electrical properties of blood plasma can be used to predict the glucose concentrations in a given sample.