Optimization of Core Sensor Components for an Osmotic Pressure Sensor for Interstitial Glucose Assessment

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Background and Aims

A new interstitial glucose sensor based on an osmotic pressure sensor technology is currently under development by Lifecare, Norway (Sencell). In the sensor core, competitive binding of glucose vs,. dextrane to specific binding sites of the plant lectine concanvalin A (Con A) is used to induce an osmotic pressure signal, which is in close correlation to interstitial glucose content. Molecular weight of dextrane and environmental temperature are supposed to influence the reproducibility and stability of the sensor signal. The purpose of this experiment was to identify the most suitable dextrane size and to assess stability of the sensor signal over months at 21°C and 37°C.

Methods

A working laboratory model of the core sensor technology was developed to perform the chemistry optimization experiments. After confirmation of proper sensor operation, three different molecular weight versions of dextrane were applied (10kDa, 40kDa, and 70kDa) in a standardized experiment and sensor sensitivity was tested over a glucose range from 2 mmol/l to 30 mmol/l. Influence of glucose concentrations on chamber fluid viscosity was tested at different ConA:dextrane concentration ratios (6:1, 3:1, and 1:1). In addition, the stability of the sensor signal was tested after 3 months of storage at 21°C and 37°C.

Results

Lowering of the ConA concentration decreased the influence of glucose on the viscosity of the active fluid most likely because the number of intermolecular bonds between dextrane and ConA is reduced. In addition, decreasing the molecular ConA:dextrane ratio from 6:1 to 1:1 resulted in a significant reduction of glucose on active fluid viscosity and enhanced the amplitude of the osmotic pressure sensor signal. The combination of 40 kDa dextrane in a 1:1 molecular ratio to ConA provided the most optimal sensor signal and was chosen for further stability experiments. When experiments were carried out at 21°C vs. 37°C, they led to comparable results. Stability of the active fluid at 37°C was confirmed by the experimental data. In addition, there was no signal of a loss of ConA integrity when assessed by UV –vis spectroscopy.

Fig.1: Schematic representation of the laboratory osmotic pressure cell

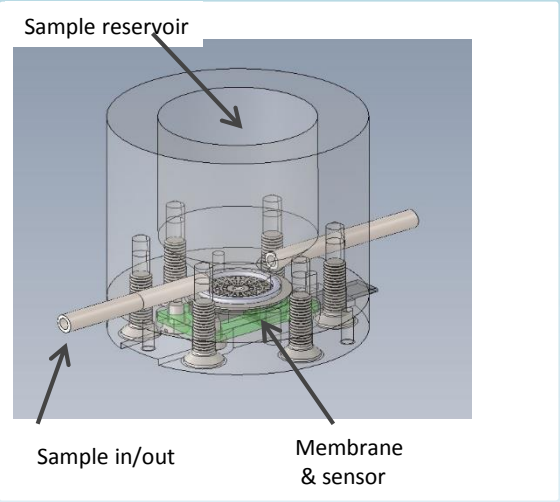


Fig.2: Typical Sensor signal when changing fom 2 mM to 30 mM of glucose in the chamber solution with dextrane 40 kDa

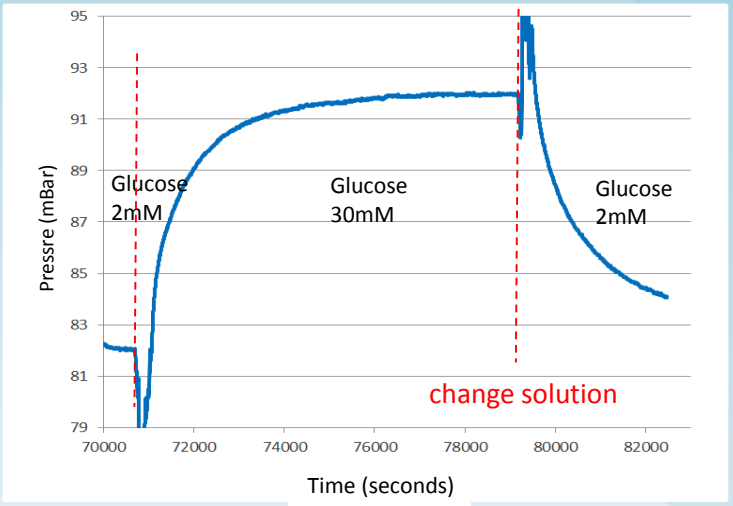
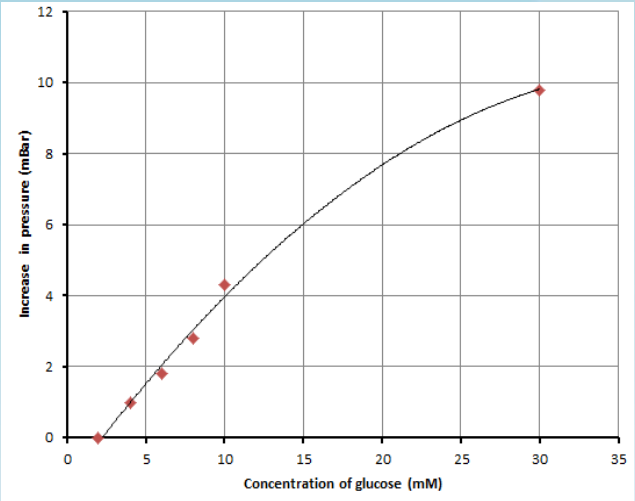


Fig.3: Dose response curve for the sensor signal at different glucose concentrations using dextrane 40kDa



Conclusions

The results of our experiments and numerical simulations enabled us to optimize the composition of the active chamber fluid and to calculate the absolute osmotic pressure that will be measured for a given concentration of glucose. In addition, our results indicate that the sensor is working with a stable performance when stored for three months at body temperature of 37°C.

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