

A Disposable Tear Glucose Biosensor—Part 3: Assessment of Enzymatic Specificity

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Abstract

Background:

A concept for a tear glucose sensor based on amperometric measurement of enzymatic oxidation of glucose was previously presented, using glucose dehydrogenase flavin adenine dinucleotide (GDH-FAD) as the enzyme. Glucose dehydrogenase flavin adenine dinucleotide is further characterized in this article and evaluated for suitability in glucose-sensing applications in purified tear-like saline, with specific attention to the effect of interfering substances only. These interferents are specifically saccharides that could interact with the enzymatic activity seen in the sensor's performance.

Methods:

Bench top amperometric glucose assays were performed using an assay solution of GDH-FAD and ferricyanide redox mediator with samples of glucose, mannose, lactose, maltose, galactose, fructose, sucrose, and xylose at varying concentrations to evaluate specificity, linear dynamic range, signal size, and signal-to-noise ratio. A comparison study was done by substituting an equivalent activity unit concentration of glucose oxidase (GOx) for GDH-FAD.

Results:

Glucose dehydrogenase flavin adenine dinucleotide was found to be more sensitive than GOx, producing larger oxidation currents than GOx on an identical glucose concentration gradient, and GDH-FAD exhibited larger slope response (-5.65×10^{-7} versus -3.11×10^{-7} A/mM), signal-to-noise ratio (18.04 versus 2.62), and linear dynamic range (0–30 versus 0–10 mM), and lower background signal (-7.12 versus -261.63 nA) than GOx under the same assay conditions. GDH-FAD responds equally to glucose and xylose but is otherwise specific for glucose.

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Abbreviations: (DM) diabetes mellitus, (GDH-FAD) glucose dehydrogenase flavin adenine dinucleotide, (GDH-PQQ) glucose dehydrogenase pyrroloquinoline quinone, (GOx) glucose oxidase, (PBS) phosphate-buffered saline, (SMBG) self-monitoring of blood glucose

Keywords: biosensor, diabetes mellitus, glucose dehydrogenase flavin adenine dinucleotide, tear glucose monitoring

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Abstract cont.**Conclusion:**

Glucose dehydrogenase flavin adenine dinucleotide compares favorably with GOx in many sensor-relevant attributes and may enable measurement of glucose concentrations both higher and lower than those measurable by GOx. GDH-FAD is a viable enzyme to use in the proposed amperometric tear glucose sensor system and perhaps also in detecting extreme hypoglycemia or hyperglycemia in blood.

J Diabetes Sci Technol 2011;5(5):1108-1115