Artificial antibodies based potentiometric sensors for monitoring diabetic ketoacidosis

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Abstract

Diabetic ketoacidosis is a pathological condition characterized for the complex disordered metabolic state (as hyperglycemia, metabolic acidosis, dehydration or ketosis), caused by the total failing of insulin production for beta cells in the islets of Langerhans (type 1 diabetes) or abnormalities in the peripheral insulin action and insulin secretion (type 2 diabetes). This pathogenesis can be also associated with the increase of counter-regulation hormones, leading to an increase in the hepatic glucose synthesis and a decrease in the peripheral tissues, resulting in hyperglycemia and hyperosmolarity. The effect of lipolysis increase leads to an increase in the production of free fatty acids, which are oxidized in the hepatic microsomal system and converted to acetyl-CoA. When acetyl-CoA production exceeds hepatic utilization capacity, this substance acts as a substrate for the production of ketone bodies (β-hydroxybutyrate (BHB), acetoacetate and acetone), causing ketonemia and metabolic acidosis.

The present work describes an original approach to create a potentiometric biomimetic sensor for BHB detection. For this purpose, a molecularly imprinted material, acting as an antibody, was obtained by bulk polymerization of acrylic acid, trimethylolpropane trimethacrylate and BHB. In parallel, a non-imprinted polymer material (NIP) was produced, following an equivalent procedure, without the target template. The chemical features of the obtained MIP materials were followed by Fourier Transform Infrared (FTIR) spectroscopy. The selective membranes were prepared by dispersing the sensing material in a plasticized PVC membrane, including or not a lipophilic ionic additive. These membranes were then casted on a solid conductive support made of graphite, placed at the smaller end of the plastic body of an insulin syringe. The analytical

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performance of the devices showed sensitive readings of BHB in wide concentration range, up to 0.01 mg/mL.

Overall, the proposed biomimetic sensor offers a simple and low-cost approach for monitoring BHB in the diabetic ketoacidosis disease, being the application to real serum samples successful.

Keywords

Diabetic ketoacidosis, β-hydroxybutyrate, Molecularly imprinted polymers, Potentiometry.

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