GRAPHENE OXIDE INTEGRATED BIOSENSING PLATFORM FOR THE DETECTION OF IN VITRO-DERIVED GLYCATED PROTEINS

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Abstract

Diabetes mellitus presents a profound global health crisis due to its chronic complications. At present, the Sri Lankan population has over 10% of diabetes, 11.5% of pre-diabetes prevalence, and overall dysglycaemia of around 21.8%. Hence, the detection of glycated proteins (GPs) in a fast way is vital for the prevention of diabetes and its complications. Despite the time-consuming techniques available worldwide for detecting GPs, this study presents a cost-effective, portable optical biosensor prototype that employs the fluorescence quenching behavior of graphene oxide (GO). The improved Hummers method was used to synthesize GO, and an *in vitro* BSA-glucose glycation model was established to prepare target protein concentrations ranging from 7.5 to 37.5 µL mL^{-1}. XRD analysis was performed to confirm the structural properties of the synthesized GO. A 370 nm ultraviolet LED was used to excite the sample, and a 440 nm band-pass filter was used to detect the fluorescence emission, reaching the Hamamatsu S1223 light-to-voltage sensor. An ADC converter (ADS1256) with an accuracy of 24 bits was used to convert the electrical signal. The device cover was designed using SolidWorks and 3D printed. X-ray diffraction confirmed successful GO synthesis, with a characteristic peak at $2\theta = 9.824°$. Baseline system validation of the prototype device demonstrated structural stability, with a coefficient of variation of 0.18%. Calibration runs demonstrated a reliable concentration-dependent linear fluorescence detection, while the integrated GP-GO matrix validated a distinct fluorescence quenching effect ranging from 5.93% to 17.46%. Further, the prototype device exhibited a sensitivity of 0.67 mV (µL mL^{-1}), revealing that the fluorescence quenching properties of the GO against GPs can be adopted for developing a cost-effective device in the detection of GPs.

Keywords: Graphene Oxide, Glycated Proteins, Optical Biosensor, Fluorescence Quenching