Design and fabrication of radiation detector based on electrochemical biosensor for use in radiation events

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Abstract

When nuclear accidents occur on a large scale, it is necessary to participate expert personnel of the Armed Forces beside civil organizations to control of such disaster. In such situations, the use of accurate and sensitive detectors to determine the contamination of environmental radioactive, food resources and people monitoring is essential. In this study, a new detector based on an electrochemical biosensor was fabricated to detect gamma radiation. Such detectors can be well used in field operations by armed forces experts. To make the biosensor, gold nanoparticles, cysteine, chitosan, and superoxide dismutase were fixed on the surface of the gold electrode. The biosensor then successfully measured the gamma ray emitted by the water-soluble thallium 201 radioisotope. In fact, the built-in biosensor was able to measure the concentration of superoxide radical produced by gamma ray in the aqueous medium. This concentration was perfectly proportional to the amount of gamma radiation. To evaluate the biosensor performance, cyclicvoltammetry and chronoamperometry experiments were performed in phosphate buffer in the presence of different doses of gamma ray. The obtained results were considered as biosensor responses. To determine the analytical parameters of the biosensor, the calibration curve was drawn using the obtained responses and the analytical parameters of the biosensor were determined. Using the calibration curve, the minimum detection limit and the sensitivity of fabricated biosensor were obtained 0.03 μM and 0.6038 nA/Gy,

respectively and the linear range was determined between 0.5 and 4 Gy. The long-term stability of the fabricated biosensor was also examined, and the results showed that in a two-month period, there was only a 17% decrease in the biosensor response. The results of this study showed that the built-in biosensor can be used as well as conventional detection methods in detecting radioactive contaminants.

Key Words: Gamma Ray, Thallium 201, Superoxide Radical, Electrochemical biosensors, Superoxide dismutase.