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An Electroanalytical Flexible Biosensor Based on Reduced Graphene Oxide-DNA Hybrids for the Early Detection of Human Papillomavirus-16

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Abstract: Human Papilloma Virus 16 (HPV 16) is the well-known causative species responsible for triggering cervical cancer. When left undiagnosed and untreated, this disease leads to life-threatening events among the female populace, especially in developing nations where healthcare resources are already being stretched to their limits. Considering various drawbacks of conventional techniques for diagnosing this highly malignant cancer, it becomes imperative to develop miniaturized biosensing platforms which can aid in early detection of cervical cancer for enhanced patient outcomes. The current study reports on the development of an electrochemical biosensor based on reduced graphene oxide (rGO)/DNA hybrid modified flexible carbon screen-printed electrode (CSPE) for the detection of HPV 16. The carbon-coated SPEs were initially coated with rGO followed by probe DNA (PDNA) immobilization. The nanostructure characterization was performed using UV-Vis spectroscopy, Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy and X-ray diffraction (XRD) techniques. Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) were employed to study the electrochemical characterization of the nano-biohybrid sensor surface. The optimization studies and analytical performance were assessed using differential pulse voltammetry (DPV), eventually exhibiting a limit of detection (LoD) ~2 pM. The developed sensor was found to be selective solely to HPV 16 target DNA and exhibited a shelf life of 1 month. The performance of the developed flexible sensor further exhibited a promising response in spiked serum samples, which validates its application in future point-of-care scenarios.

Keywords: HPV-16; cervical cancer; rGO/DNA hybrids; flexible genosensor; screen-printed electrodes; point-of-care

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1. Introduction

Cancerous infections arising due to the incursion of Human Papillomavirus (HPV) in the cervix leads to increasing fatalities among the women of developing nations, which results in devastating outcomes [1]. The annual global cases related to cervical cancer has been reported to be as high as 5.2 Lakhs to which India contributes approximately 1.2 Lakh cases every year [2]. HPVs are often classified into two types—high-risk and low-risk, with the former category including HPV 16 and HPV 18 types. These species are equally fatal as evidenced by their prevalence in more than half (70%) of cervical cancer scenarios [2]. In numerous cases of untimely diagnoses, such cancers become malignant which leads to fatal outcomes such as lymph node infringement, inflammation and eventually death [3].