Electrochemical miRNA Detection using Gold-Decorated Reduced Graphene Oxide Modified Paper Electrodes

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Abstract

Paper-based biosensors are recognized as simple, cost-effective platforms for analytical testing and diagnostics. Over the last decade, they have gained significant attention due to their ease of use, disposability, and low-cost production [1]. These sensors also offer advantages like rapid analysis and the ability to work with small sample volumes, making them promising alternatives to conventional point-of-care devices [2]. Electrochemical detection techniques are cost-effective and offer high selectivity and sensitivity. Paper-based sensors can be perfectly integrated with electrochemical techniques. A standard paper-based electrochemical sensor typically consists of a paper substrate, an electrode area, and two or three electrodes [3]. Cancer, one of the most common genetic diseases, is associated with miRNAs due to their crucial role in regulating gene expression. miRNAs function as either oncogenes or tumor suppressors by inhibiting their respective oncogenic or tumor-suppressive target mRNAs [4]. For instance, miRNA-15, miRNA-16, miRNA-21, miRNA-155, and miRNA-372 are found to be significantly overexpressed in various tumors, contributing to oncogenesis [5]. In this study [6], a paper-based electrochemical biosensor was developed for the rapid and sensitive detection of miRNA-21, aiding in the early diagnosis of lung cancer. The working electrode area was modified with a hybrid structure of reduced graphene oxide and gold nanoparticles. The entire process of our assay, from electrode modification to miRNA detection, was completed in just 35 minutes, with a detection limit 12 nM for miRNA-21 target sequence [6]. Moreover, our biosensor demonstrated sufficient selectivity to differentiate the target miRNA from single-base mismatch miRNA or non-complementary miRNA sequences.

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