Carbon Coated Magnetic Nanoparticles Based Assay for Electrochemical Detection of Hepatitis B virus DNA

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Abstract

Magnetic particles have gained significant popularity in the field of biotechnology, medicine, and analytical biochemistry for their effective use in immobilizing and separating proteins, enzymes, and other bioactive agents. The iron oxide core has the potential to serve as nanoscale magnetic particles exhibiting superparamagnetic properties. These nanoparticles can form stable suspensions in aqueous media and can be easily dispersed again after agglomeration when subjected to a magnetic field [1,2]. Electrochemical DNA biosensors are anticipated to play a vital role in point-of-care diagnostics under medical supervision in the future [1-3]. Furthermore, there has been a significant increase in biotechnological investigations employing magnetic particles for the analysis of nucleic acids, specifically focusing on the detection of sequence-specific nucleic acid hybridization using electrochemical sensors [4-8]. Our study [8], aims to develop amino-functionalized carbon-coated magnetic nanoparticles (cc-MNPs) and utilize them for electrochemical detection of Hepatitis B virus (HBV) DNA sequence. Under this aim, sequence selective DNA hybridization related to HBV gene sequence have been carried out at the surface of cc-MNPs. After the sequence-selective DNA hybridization detached from the surfaces of these nanoparticles, the electrochemical detection of full DNA hybridization was investigated using pencil graphite electrodes (PGE) in combination with differential pulse voltammetry (DPV) technique by measuring the guanine oxidation signal. In order to improve hybridization efficiency, experimental parameters affecting all assay steps (i.e. DNA probe concentration, hybridization time, target DNA concentration) are studied and the analytical performance of the sensor was tested and the selectivity of this assay was examined. The detection limit was found to be 1.15 µg/mL [8]. Our magnetic nanoparticles-based assay offered a chemically and electrochemically stable, powerful, cost-effective, selective, sensitive, and rapid technique for nucleic acid detection related to HBV DNA resulting in a low detection limit.

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References

[1] J. Wang, A.-N. Kawde, A. Erdem, M. Salazar, Analyst, 126 (2001) 2020-2024.
[2] E. Palecek, M. Fojta, Talanta 74 (2007) 276–290.
[3] J. Wang, Anal. Chim. Acta 469 (2002) 63-71.
[4] Y. Chang, Y. Wang, J. Zhang, Y. Xing, G. Li, D. Deng, L. Liu, Biosensors 12 (2022) 954.
[5] A. Erdem, G. Congur, E. Eksin, Sens. Act. B 188 (2013) 1089-1095.
[6] A. Erdem, E. Eksin, Int. J. Biol. Macromol. 125 (2019) 839-846.
[7] I. Gessner, J.W.U. Fries, V. Brune, A. Mathur, J. Mater. Chem. B 9 (2021) 9-22.
[8] C. Altay, R.H. Senay, E. Eksin, G. Congur, A. Erdem, S. Akgol, Talanta 164 (2017) 175-182.