Nanobiosensing architectures for the detection of β-1,4-Galactosyltransferase-V colorectal cancer biomarker

Danilo Echeverri
Jahir Orozco
Max Planck Tandem Group in Nanobioengineering, Institute of Chemistry, Faculty of Natural and Exact Sciences, University of Antioquia. Complejo Ruta N, Calle 67 N°52–20, Medellín, Colombia
grupotandem.nanobioe@udea.edu.co

β-1,4-Galactosyltransferase-V (β-1,4-GalT-V) is a glycosyltransferase that glycosylates high-branched N-glycans. Colorectal cancer (CRC) tumor cells overexpress this glycosyltransferase concerning normal cells and release it into the body fluids [1]. Conventional methods such as immunoassays and liquid chromatography-based methods enable the determination of the β-1,4-GalT-V accurately but have limitations, including the use of sophisticated and centralized laboratory equipment and skilled personnel. Thereby, there is a need for the detection of β-1,4-GalT-V at the point of care.

Electrochemical biosensors allow overcoming the challenge of β-1,4-GalT-V glycoprotein detection. These biosensors enable the affordable and accurate detection of the analyte at low concentrations, with high specificity, in simple formats, and with rapid response [2]. We developed bare and nanostructured electrodic architectures to detect the colon cancer biomarker β -1,4-GalT-V by electrochemical impedance spectroscopy (EIS) and electrochemical capacitance spectroscopy (ECS). Both biosensors use an antibody immobilized onto the electrode surface, which recognizes the analyte by biochemical affinity [3]. The resultant biosensors were highly specific for the β-1,4-GalT-V, whose response was linear from 5 to 150 pM (r^2 = 0.993), with a limit of detection (LOD) of 7 pM, for the bare architecture. We further enhanced the sensitivity toward the glycosyltransferase detection in a linear range from 50 to 400 fM (r^2 = 0.994) and lowered the LOD 350-fold down to 20 fM for the nanostructured architecture. Therefore, we report ultrasensitive biosensing interfaces that could be used as a label-free approach to detect and quantify β-1,4-GalT-V at clinical relevance concentrations and quantify it in raw human serum samples, thus holding considerable potential for determining this cancer biomarker and other proteomic cancer-related biomarkers.

References

[1] S.B. Chatterjee, J. Hou, V.V. Ratnam Bandaru, M.K. Pezhouh, A.A. Syed Rifat Mannan, R. Sharma, Biochemical and Biophysical Research Communications, 2 (2019) 380–386.
[2] Quinchia J, Echeverri D, Cruz-Pacheco A F, Maldonado M E and Orozco J A, Micromachines, 11 (2020) 1
[3] D. Echeverri, J. Orozco, Talanta, 243 (2022) 123337.

Figures

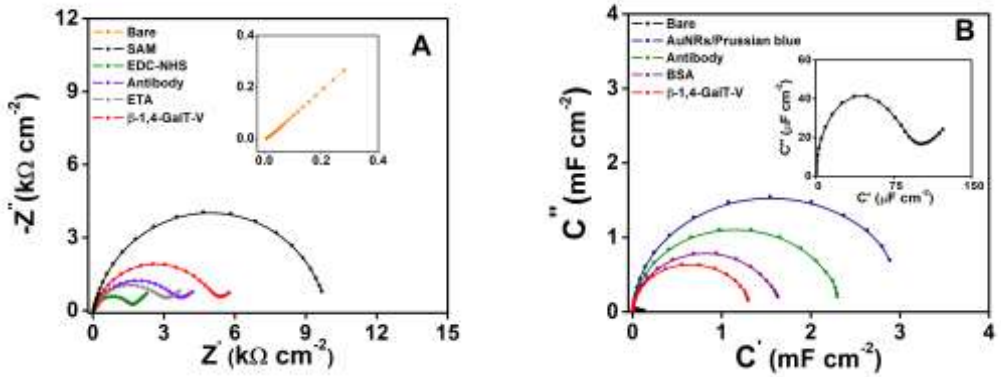

Figure 1: Nyquist plots of the development of the biosensors. (**A**). Impedimetric biosensor (**B**). Capacitive biosensor.