Nanomaterials based Microfluidics Integrated Glycated Haemoglobin Sensing Platform for Diabetes Management

Praveen Lakhera[1, 2, 3], Parveen Kumar[1, 2], Cesar Sanchez Huertas[3], Crispin Szydzik[3], Arnan Mitchell[3], Sanjeev Kumar[1, 2]

[1]CSIR-Central Scientific Instruments Organisation, Sector 30-C, Chandigarh 160030, India.
[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India.
[3]Integrated Photonics and Applications Centre, School of Engineering, RMIT University, Melbourne, VIC, 3001, Australia.

Abstract:

Diabetes is clinically defined as hyperglycaemia, which poses long-term risks to various physiological functions effecting different organs and systems crucial for overall health. When glucose present in blood binds to haemoglobin protein forms glycated haemoglobin i.e., known as HbA1c. The detection of HbA1c has played a significant role in the long-term monitoring of glucose levels, aiding in the diagnosis of diabetes [1]. The Integration of enzymatic based glucose sensor into everyday applications encounters limitations attributed to factors like prohibitive cost, inadequate long-term stability, and suboptimal reproducibility [2]. To address these constraints, an alternative method for the direct determination of glucose has been developed through non-enzymatic based sensors employing nanoparticles. Such method offers significant advantages in terms of affordability, heightened stability, reliable reproducibility, and excellent recyclability [3].

In this study, we introduce a microfluidics integrated non-enzymatic sensor platform utilizing nanomaterial composite, facilitating specific sensing of glycated haemoglobin. Under optimized conditions, the developed nanomaterial-based sensing method exhibited wide sensing response by using electrooptical method of detection from real blood sample. Furthermore, the sensing was tested in microfluidics platform which increase the reliability of sensing mechanism with real world applications. The Microfluidics platform also enabled simultaneous detection of hemoglobin and glycated hemoglobin from the real blood sample within the clinical range. Obtained results highlight the potential of the nanoparticles-integrated microfluidics platform for the highly sensitive non-enzymatic glycated haemoglobin sensing platform for diabetes detection and management.

Keywords: Diabetes; Biosensor; Glycated Haemoglobin; Nanomaterials, Microfluidics.

References:

[1] Batur, T., Akbay, H. İ., Çokluk, E., & Esendemir, A. (2023). Evaluation of the hemoglobin a1c test in detecting pediatric prediabetes. *Journal of Contemporary Medicine*, 13(1), 1-5.

[2] Liu, J., Shen, J., Ji, S., Zhang, Q., & Zhao, W. (2023). Research progress of electrode materials for non-enzymatic glucose electrochemical sensors. *Sensors & Diagnostics.*

[3] Naikoo, G. A., Arshad, F., Hassan, I. U., Omar, F. B., Tambuwala, M. M., Mustaqeem, M., & Saleh, T. A. (2023). Trends in bimetallic nanomaterials and methods for fourth-generation glucose sensors. *TrAC Trends in Analytical Chemistry*, 117042.