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VIRUS DETECTION USING SCREEN-PRINTED CARBON ELECTRODES

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Background

Viruses are small infectious nonliving agents that invade living organisms to replicate. Viruses can cause disease, corruption, and death of the host. Today, it is especially important to detect SARS-CoV-2 also known as the Coronavirus (Covid-19) to control the spread. In this research we focus on detecting Covid-19 nucleocapsid protein using electrochemistry and immunoassay techniques to increase detection time, sensitivity, and accuracy.

Methods

By immobilizing an immunoassay onto a screen-printed carbon electrode (SPCE) and using a potentiostat to undergo electrochemical analysis, we are able to measure the presence of Covid-19 nucleocapsid protein. The immunoassay is made up of antibodies, bovine serum albumin, nucleocapsid protein, and gold-nanoparticles (AuNPs). To prepare the immunoassay we use passive absorption to attach the capture antibody to the electrode. The analyte and labelled antibody are then attached followed by a series of rinses with phosphate-buffered saline (PBS). Then we use Square Wave Voltammetry (SWV) to measure the current-potential relationships in the electrochemical cell. The higher the current the more AuNPs are attached, and thus, the more protein of analyte is present.

Results

Covid-19 nucleocapsid protein is detectable at concentrations of 10ng/mL and 100 ng/mL by SWV. SWV showed signs of non-specific binding which occurs when gold binds to the electrode or other antibodies despite the absence of the protein. Rinsing with copious quantities of PBS alone was not sufficient to wash the electrode of nonspecific binding molecules. PBS with 0.05% Tween20 (PBST) washed off not only hydrophilic interaction but also hydrophobic interactions preparing the immunoassay with less non-specific binding. Scanning Electron Microscope imaging confirmed that gold nanoparticles are on the electrode surface. 10nm gold particles give the best electrochemical signal and is the optimal size for detection although particle aggregation is probable. Drying the immunoassay on the electrode influences diffusion coefficient and electrochemistry. The limit of detection is 7x10^8 AuNP/mL (20nm). The optimal scan rate for 10 nm gold detection is 75 mV/s.

Conclusion

As we continue this research to optimize the virus detection using screen-printed carbon electrodes, we will be able improve detection of Covid-19. This research can be expanded and optimized for other pathogens using screen-printed electrodes to similarly develop timely, accurate, sensitive detection.