Practical Detection of COVID-19 by Personal Glucose Meter and Signal Nanoplatform

İlker Polatoğlu[1]
Erdal Eroğlu[1], Muhammet Burak Batır[2]
Manisa Celal Bayar University, Bioengineering Department[1], Department of Medical Genetics[2], Manisa, Turkey
ilker.polatoglu@cbu.edu.tr

Abstract

For the COVID-19 pandemic, which is constantly on our agenda, it is possible to control the infection rate, minimize the risk of transmission and start early treatment of sick individuals by rapid detection of this disease. While PCR-based methods performed in the hospital for the detection of COVID-19 provide results with a high accuracy rate in the early stages, serological-based kits allow individuals to test themselves at home [1]. In this study; this is the first time a nucleic acid-based signal nanoplatform capable of in situ analysis (POC) for COVID-19 detection with high accuracy was developed. Another basic feature of this technology is that the strips of the existing glucose meter device, which is easily accessible to everyone, can be used for the detection of COVID-19.
For this aim, firstly, 3 target genes were selected from the regions with the lowest mutation rate and the lowest probability of matching within themselves, and probe DNAs were determined by taking the conjugates of the target gene sequences. The signal nanoplatform (MAP) was obtained by binding these DNAs to magnetite nanoparticles (MNP) modified with amine groups (Figure 1A). On the other hand, invertase enzyme was bounded to target DNA probes (Figure 1B) with the method suggested by Xiang and Lu [2]. For COVID-19 detection, the designed MAP was interacted with samples with and without viral genome (target DNA), and after the liquid phase was separated, invertase-DNA conjugate was added to the MAP. Different signals were obtained from the glucose meter depending on the target DNA concentration as a result of the reaction between the MAP with sucrose.
It was revealed by SEM, EDX, and FTIR analyses that MNPs were modified with amine group. Qubit measurements revealed that approximately $887^{\pm170}$ ng of probe DNA was attached to the modified MNPs, and the 3 different probe DNA sequences did not interact with each other. It was clearly seen in the agarose gel that the target and probe DNAs did not match within themselves but hybridized with their conjugates to form dsDNA. In the experiments performed in phosphate buffer, the signal value for the negative sample (without target DNA) was found to be 344 mg/dl, and the signal value for the positive sample (including 361 ng of target DNA) was found to be 101 mg/dl. In the samples taken from individuals who were revealed to be COVID-19 positive and negative by PCR results, high signal values (>600 mg/dl) for negative case samples, and values below 358 mg/dl were obtained for positive cases as expected. The developed MAP also has a qualification to be used in other infectious diseases, cancer, pathogen, and GMO analyses by simply altering the probe DNA sequences.

References
[1] Kubina, R., Dziedzic, A., Diagnostics, 10(6) (2020).
[2] Xiang, Y., Lu, Y., Analytical Chemistry, 84(4) (2012) 1975–1980.

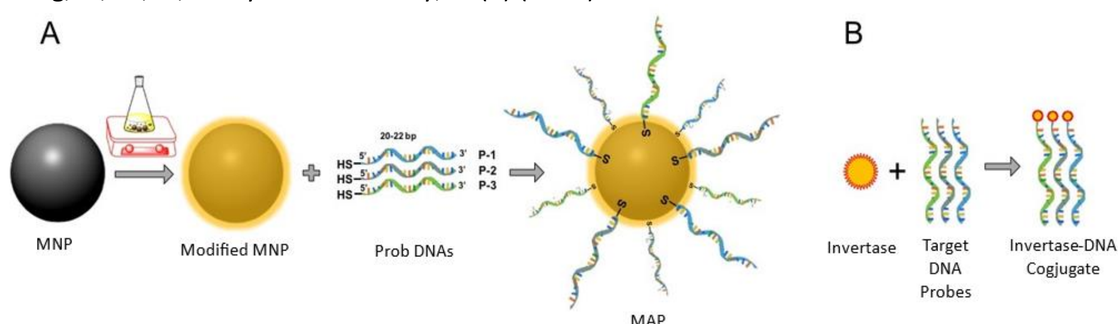

Figure 1: A) Designed signal nanoplatform (MAP), B) enzyme bounded target DNA probes.