Paper-based electrochemical sensor for the detection of essential oils and SARS-CoV-2 virus

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1. Introduction

Paper-based sensors have emerged as promising platforms for the detection of various analytes due to their affordability, simplicity, and portability. Utilizing the inherent properties of paper, such as its porous structure and compatibility with functionalization processes, we developed in the last years several sensors and biosensors capable of selectively detecting target analytes in different fields including biomedical, environmental, agrifood, and defence [1].

It is worth noting that these sensors have demonstrated effectiveness in detecting both chemical and biological compounds, thus expanding their potential application field. The ability to detect analytes of different natures, such as organic molecules or biomolecules, makes these sensors extremely versatile and useful in a variety of contexts, from medical to environmental, from food industry to food safety.

2. Results

Herein, we present the results obtained within European Project Horizon Europe Reliance for monitoring the efficiency of the environmentally friendly antimicrobial coating developing a paper-based sensor for the electrochemical detection of essential oils namely thymol, eugenol, and carvacrol and a sandwich-type immunosensor to reveal SARS-CoV-2 virus in a paper-based origami configuration.

For the electrochemical measurement of both analytes, we functionalized the working electrode by drop casting with carbon black, demonstrating improved sensitivity using this affordable nanomaterial, in agreement with our previous articles [2].

The essential oils are revealed in solution by adding a drop directly on the sensor, as well as by sampling the target analyte on the surface and in the aerosol phase. The detection limit was 0.4, 0.4, and 0.6 ppm, with RSD % equal to 2 %, 1 %, and 3 % for thymol, eugenol, and carvacrol respectively.

For SARS-CoV-2 detection, a paper-based origami immunosensor has been designed. This biosensor incorporates specific recognition elements namely magnetic beads

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coated with a capture antibody against spike protein and a recognizing antibody labelled with alkaline phosphatase enzyme. SARS-CoV-2 virus is revealed after the addition of the substrate on paper-based screen-printed sensor, enabling rapid and sensitive detection. It's important to note that all immunorecognition steps are merged in one single step conducted inside waxed paper wells permitting the origami configuration.

3. Conclusions

Our results demonstrate the successful fabrication and characterization of these paper-based (bio)sensors, showcasing their potential for diverse applications in healthcare, environmental monitoring, and beyond. This work highlights the versatility and effectiveness of paper-based sensors as robust tools for real-time analyte detection, paving the way for advancements in sensor technology.

4. References

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