PAPER-BASED DEVICE FOR MONITORING ECO-FRIENDLY ANTIMICROBIAL COATING EFFECTIVENESS

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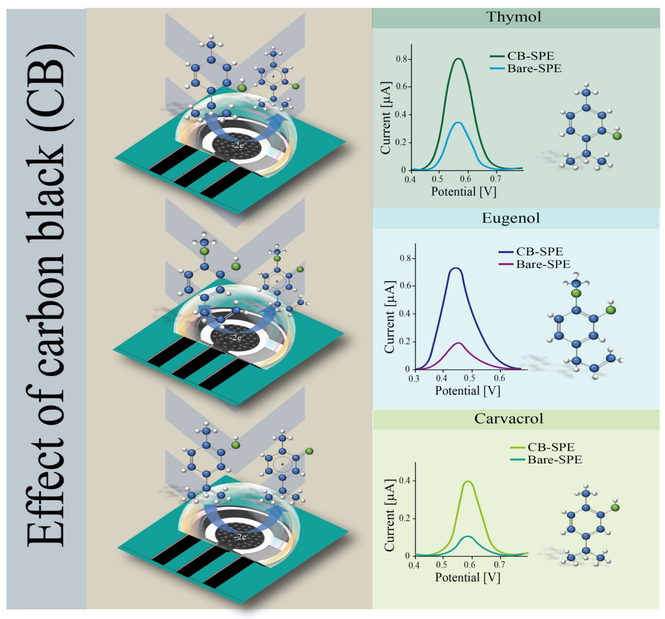
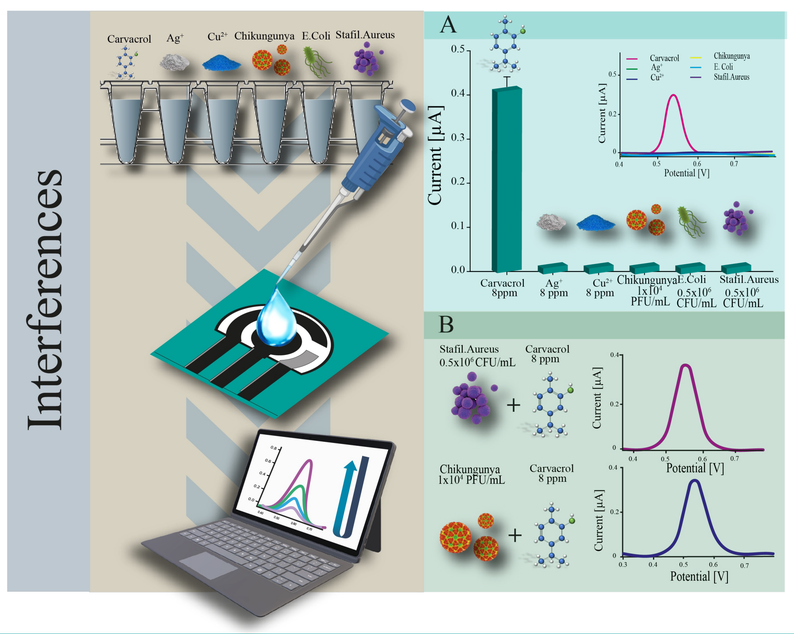
Abstract

In the era of sustainability, the use of natural compounds as antimicrobial compounds is the rational selection to avoid the release of pollutants into the environment. Among natural compounds, essential oils are characterized by reliable antimicrobial activity and their use is estimated to grow in the future, thus their detection is an asked point. Herein, we report an electrochemical paper-based device for the detection of essential oils, namely thymol, eugenol, and carvacrol by adding a few µL of solution onto the electrode, as well as by sampling the target analyte on the surface and in the aerosol phase, demonstrating its capability to work as both sampling system and sensor. We functionalized the working electrode by drop casting with carbon black, demonstrating improved sensitivity using this affordable nanomaterial. To deliver a reagent-free device, the paper-based electrode was loaded with the working buffer for asking the end-user only the contact with the sample. This sensor detects the selected essential oils in a dynamic linear range of up to 16 ppm, with a detection limit equal to 0.1, 0.1, and 0.2 ppm for thymol, eugenol, and carvacrol, respectively. The reliable results demonstrated the versatility of the paper-based electrochemical sensor, enlarging its use in essential oil detection.

CB-based electrode for the detection of EOs

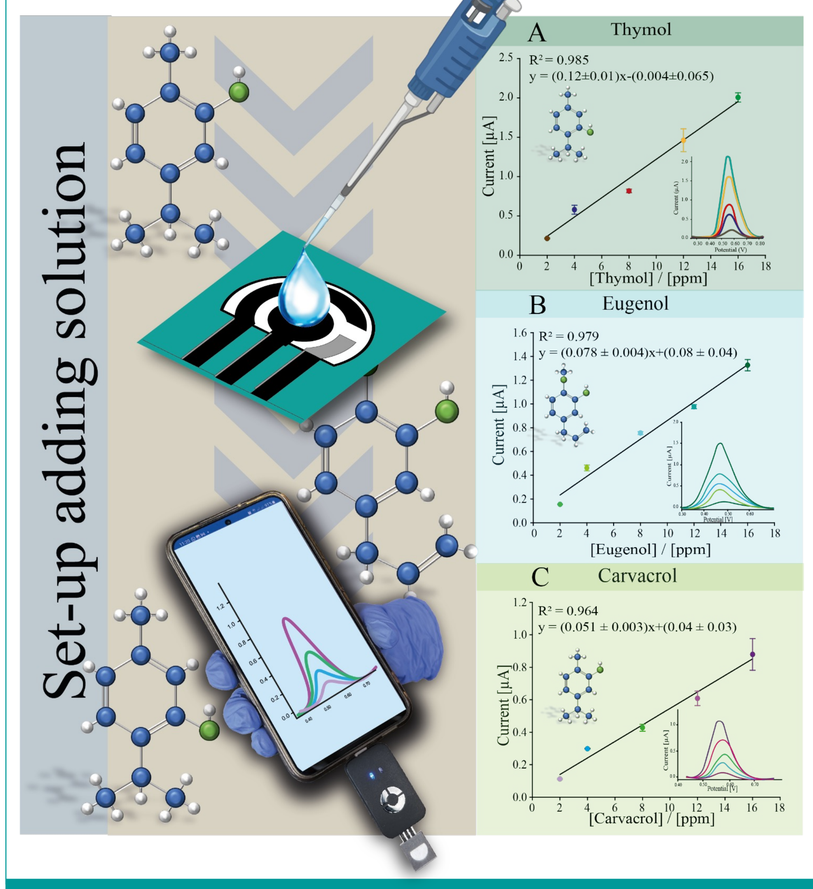


The modification of the working electrode surface with CB was demonstrated to be useful for the sensitive detection of EOs. In the presence of CB modification, the sensor gives a higher-intensity oxidative peak of thymol, eugenol, and carvacrol, as shown in Figure 2. Indeed, the presence of CB dispersion on the working electrode surface increased the sensitivity, attributable to its high conductivity and high surface area.

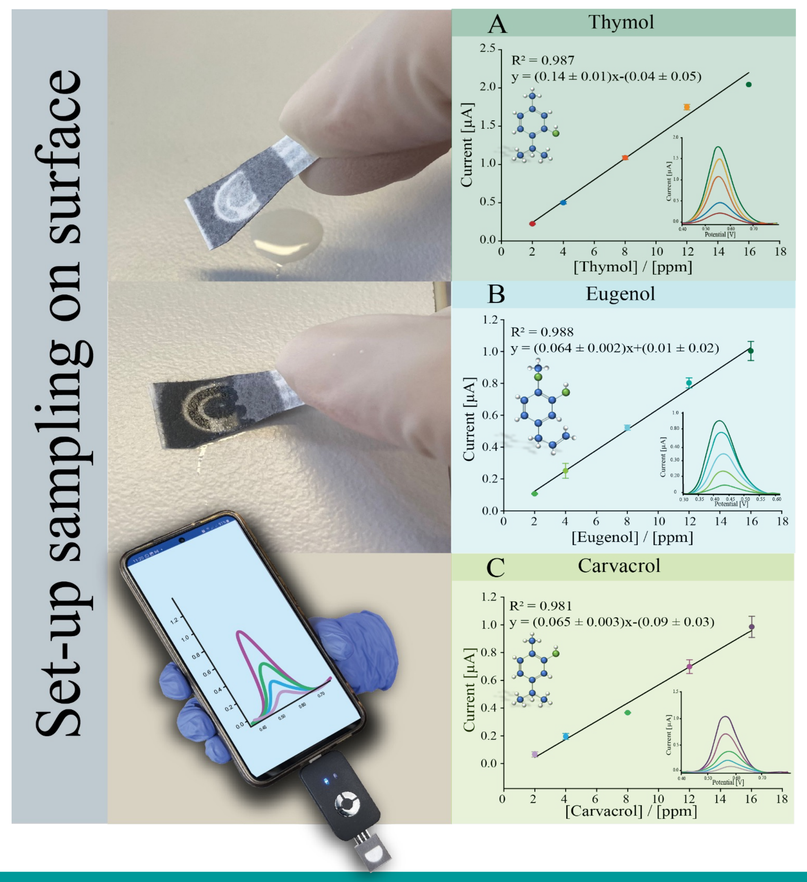


The selectivity of the CB-paper-based sensor was evaluated by investigating the effects of mainly other used electroactive antibacterial agents, namely Ag^+ and $Cu2^+$, and in the presence of bacteria/viruses, such as CHIKV, Escherichia coli, and Staphylococcus aureus.

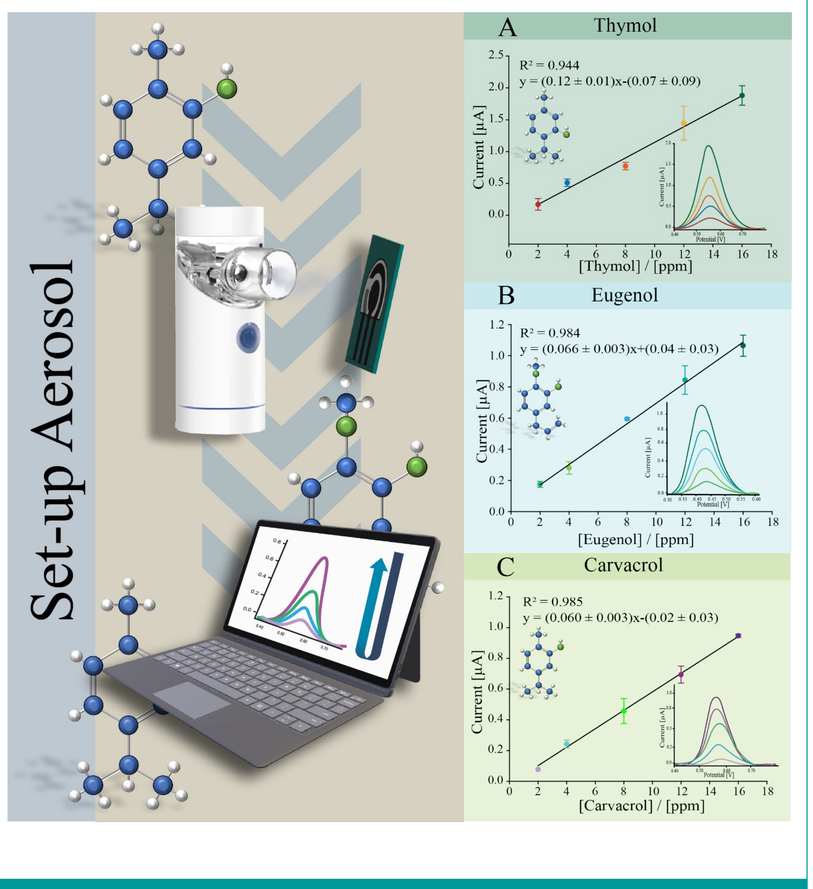
EO detection in standard solution



Sampling EOs directly on the surface



EOs detection in the aerosol phase



Conclusion

In this work, the first paper-based electrochemical sensor for the detection of essential oils is reported. It is important to highlight that the sensor is conceived as a reagent-free device, being the salt of acetate buffer pre-loaded before the measurement. The same analytical features obtained in these different conditions highlight the robustness of this paper-based device, boosting its wide use in the detection of these natural antimicrobial agents. Finally, we can say that natural antimicrobial agents can be detected with environmentally friendly devices, following the vision of sustainability.

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