A Portable 3D-Printed Platform for Electrochemical LAMP-Based MRSA Diagnostics

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Methicillin-resistant *Staphylococcus aureus* (MRSA) has become one of the most challenging multidrug-resistant bacteria. Early diagnosis is therefore essential to enable rapid intervention and correct treatment for MRSA [1]. We present a novel fully 3D-printed electrochemical device for MRSA detection using Electrochemical Loop-Mediated Isothermal Amplification (E-LAMP). Synergizing the miniaturization, scalability, and cost-efficiency of 3D printing with E-LAMP's molecular specificity and rapid analysis establishes it as a competitive alternative for clinical and environmental applications [2,3]. The devices were 3D-printed using polylactic acid (PLA) for the structural components and conductive carbon-based PLA (ProtoPasta) for the electrodes. A 455 nm-laser treatment was applied to partially remove the plastic content and improve the electrochemical performance of devices [2]. The laser parameters (Power: 25% (5 W), Speed: 60 mm s^{-1}) were optimized using a Central Composite Design (CCD), evaluating the electrochemical response of $[Ru(NH_3)_6]^{3+}$ redox probe, with a Relative Standard Deviation of 5.3% for ΔEp and 1.76% for I_{pa} (n=6). The E-LAMP response is based on detecting the protons released during the DNA amplification step of the LAMP technique. Changes in H^+ concentration induce a shift in the oxidation peak of the pH-sensitive cresol red dye [3], obtained by Linear Sweep Voltammetry. The device showed a low LOD (11 copies μL^{-1}) in 31 min total analysis time, showing high specificity for MRSA in real samples (5 positive/5 negative). The E-LAMP test enables robust, low-cost, and decentralized diagnostics.

Acknowledgments:

The authors acknowledge FAPESP, CNPq, and CAPES for financial support.

References:

[1] Lee, A. S. *et al.*, Nature Reviews Disease Primers, 4, 18033 (2018)
[2] Carvalho, M. S. *et al.*, Electrochimica Acta, 506, 144995(2024)
[3] Rioboó-Legaspi, P. *et al.*, Lab Chip, 24, 4085(2024)