Eco-Friendly Paper-Based Electrochemical Sensor Using LIG and AuBNPs for Sensitive Histamine Detection

Juliana M. Dias[1,2,3], Gabriel M. Marin[1], Elsa M. Materón[3], Ketley C. R. Pereira[2,3], Sergiane C. Barbosa[1], Ednei G. Primel[1], Cecilia de C. C. e Silva[2, 3], Daiane Dias[1]

[1] FURG, [2] Mackenzie, [3] Mackgraphe

**e-mail: martinsdiasjuliana@gmail.com*

In the field of advanced materials, sustainability aligns with the search for new substrates and preparation techniques for high-performance materials, particularly for applications in electronics, food, healthcare, and the environment. From this perspective, the development of advanced nanomaterials stands out due to the emerging production of laser-induced graphene (LIG) from abundant and renewable raw materials, such as paper [1]. In this context, the present work produced an electrochemical sensor based on LIG, synthesized using a UV laser on a kraft paper substrate. Furthermore, the sensor was modified with biogenic gold nanoparticles (AuBNPs), synthesized from an aqueous extract of orange peel, for the detection of histamine in fish samples. The results confirm the formation of graphitic structures, as evidenced by Raman spectra that display the presence of D, G, and 2D bands, and the predominance of sp^2 bonds, which is further confirmed by XPS analysis. Additionally, SEM, confocal microscopy, and sheet resistance analyses indicated structural changes, revealing increased surface roughness (4.57 μm) and low sheet resistance (43.06 ± 1.79 Ω/□). Electrode modification was monitored by FTIR, and the analytical performance was evaluated using the SWV technique. The results demonstrated a linear range from 0 to 1.25 g L^1, a LoD of 0.17 mg L^1, a LoQ of 0.54 mg L^1, and good selectivity in the presence of other biogenic amines. The analysis of spiked fish samples yielded recovery values comparable to those obtained by HPLC-MS/MS (9.89 ± 0.54 g L^{-1}, RSD 1.02%) and SWV (9.15 ± 0.15 g L^{-1}, RSD 1.67%) techniques. Finally, the sensor demonstrates exceptional performance and represents a significant breakthrough in the field of sustainable electrochemical sensors.

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