The utilization of state-of-the-art graphene derivatives in electrochemical sensor technology for the detection of neonicotinoids

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Neonicotinoids, widely used herbicides in agriculture, have become a key focus of research due to their potent acute toxicity and neurotoxic effects resulting from prolonged exposure [1]. The main goal of this study is to develop an innovative electrochemical sensing material using state-of-the-art graphene derivates [2][3] for monitoring neonicotinoids level in the environment. To achieve this goal, we selected and evaluated four graphene derivatives—graphene acid (GA), graphene acid with iron nanoparticles (GAFe), nitrogen-doped graphene (GN3) and cyano-graphene (GCN) —as potential candidates for detecting structurally similar pesticides [4,5]. The sensor was characterized using electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV) and square-wave voltammetry (SWV). The results indicate that these derivatives exhibit improved analytical performance compared to a bare glassy carbon electrode (GCE), which can be attributed to their high conductivity and enhanced electron transfer ability on the electrode surface. Optimization of the square-wave voltammetry technique and pH value was carried out using a factorial design. The GCE/GAFe-based sensor demonstrated a significant electrochemical response to paraquat (PQ), with a sensitivity of 0.07 (μA/mM), correlation of 0.984, and a linear range of 0.05 to 1. 25mM. These findings highlight the potential of graphene-based materials for efficient and sensitive detection of neonicotinoids and structurally related pesticides, such as paraquat, thiamethoxam, and imidacloprid.

References

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