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Electrochemical Investigation of Thiamethoxam on Glassy Carbon Electrode

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Thiamethoxam (TMX) is one of the most widely used neonicotinoid pesticides in modern agriculture due to its unique properties, such as low toxicity to non-target animals, including humans and mammals, with high target specificity; a broad spectrum of insecticidal action; and versatility in application methods. However, its persistence and water solubility contribute to environmental contamination and potential health risks, requiring sensitive detection methods. Electrochemical methodologies, due to their cost-effectiveness and efficiency, offer a promising alternative to traditional techniques such as high-performance liquid chromatography and gas chromatography, which are tedious and costly and require specially trained personnel for operation. This study investigates the electrochemical behavior of TMX on a glassy carbon electrode (GCE) as a foundation for developing such electrochemical methodology. Cyclic voltammetry (CV) and square wave voltammetry (SWV) were used to characterize the reduction of TMX in various buffer solutions. The results revealed an irreversible reduction peak at -1.24 V, attributed to the reduction of the nitro group of TMX, occurring via a diffusion-controlled process in pH 9.0 Britton-Robinson buffer (BRB) according to the peak current–scan rate relationship. More importantly, SWV demonstrated higher sensitivity than CV for the detection of TMX. Square wave voltammograms obtained at different pH values suggested that the maximum current was generated in pH 9.0 BRB. Although amperometric studies demonstrated the detection of TMX at the bare GCE, electrode fouling was observed as the large pesticide molecules interfere with the active surface for electrochemical reactions, suggesting the necessity of surface modification for improved analytical performance. This research establishes the feasibility of electrochemical methods for TMX detection and proposes the necessity of electrode surface modification to mitigate electrode fouling and enhance sensitivity.

Keywords:

Amperometry, Cyclic voltammetry, Electrochemistry, Glassy carbon electrode, Thiamethoxam.

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