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Modification of carbon paste electrodes with recrystallized zeolite for simultaneous quantification of thiram and carbendazim in food samples and an agricultural formulation

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Abstract

A simple, inexpensive, highly sensitive, selective novel electrochemical method was developed for simultaneous quantification of the fungicides thiram and carbendazim in samples of honey, fresh grape juice, and an agricultural formulation using a carbon paste electrode modified with recrystallized zeolite. Zeolite was characterized by TG-DSC, XRD, FT-IR, and SEM-EDS before and after recrystallization treatment. The electrodes were electrochemically characterized using cyclic voltammetry, square-wave voltammetry, and electrochemical impedance spectroscopy. Electrode area, standard heterogeneous rate constant, and double-layer capacitance were the electrochemical variables investigated. Recrystallized zeolite had a strong influence on these variables. Development of the method for simultaneous thiram and carbendazim quantification involved optimizing instrumental parameters (frequency, amplitude, and potential step) and experimental parameters (pH, zeolite content, temperature, and recrystallization time). The oxidation peak current for thiram varied linearly in the concentration range of 0.36-4.99 $\times 10^{-7}$ mol L^{-1}, with limit of detection (LD) of 6.74 $\times 10^{-9}$ mol L^{-1} and limit of quantification (LQ) of 20.17 $\times$