Exploring biochar potential for electrochemical sensing of pesticide maneb

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The great potential of biochar as a low-cost material obtained from renewable resources for the development of electrochemical sensors is recognized for the analysis of various electroactive organic compounds [1-3]. In this study, an electrochemical sensor based on biochar derived from a hardwood source as an environmentally sustainable material is used as a modifier of carbon paste electrode (CPE) to improve the voltammetric determination of pesticide maneb (MAN). Maneb belongs to the group of dithiocarbamate fungicides that could be used for the treatment of fruits and vegetables. The increase of dithiocarbamates metabolite concentrations in the environment may disrupt protein synthesis and metabolism. Therefore, a rapid, simple, and sensitive analytical approach for the analysis of MAN is needed [4]. Biochar (BC) material was prepared from hardwood at two temperatures, 400 °C (BC400) and 700 °C (BC700), and characterized by scanning electron microscopy, and specific surface area analysis. Obtained results showed a porous structure of BC with relatively high surface areas, *i.e.* 176 $m^2 g^{-1}$ at 400°C and 284 $m^2 g^{-1}$ at 700°C. As it is expected, BC produced at high temperatures has a higher surface area and better conductivity [5]. Due to the good catalytic properties of BC as a material, an enhanced sensitivity of electrochemical sensors based on BC could be achieved [6]. Accordingly, observed oxidation peak intensities have shown the differences between an unmodified CPE, CPE modified with a BC400 (BC400-CPE), and CPE modified with a BC700 (BC700-CPE) for the analysis of MAN whereby BC700-CPE provides the most favourable analytical response of target analyte. Cyclic voltammetric investigations revealed that the electrode reaction is irreversible and controlled by the adsorption of MAN at the surface of the working electrode, which led to an optimization of the differential pulse adsorptive stripping voltammetric (DP-AdSV) method for quantifying MAN in a model solution. Under the optimized experimental parameters (10.0 % BC700 in CPE, Britton-Robinson buffer pH 7.0, E_{acc} = -0.2 V, t_{acc} = 90 s), the oxidation peak of MAN (at 0.55 V) showed a linear response in a concentration range from 0.049 to 1.84 μg mL^{-1} with evaluated limit of detection of 0.015 μg mL^{-1} and relative standard deviation of 3.23 %. The obtained results open the possibility of exploring BC700-CPE potential for MAN determination in environmental samples.

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