# Use of hardwood biochar for the development of a sensitive electrochemical sensor for the determination of pesticide mancozeb in wastewater sample

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## INTRODUCTION

The levels of pesticides in water have increased due to their excessive use in the modern agricultural domain indicating the need for the development of simple and contemporary methods for their removal and determination. The preparation and application of biochar (BC) have attracted strong interest due to its fascinating physicochemical properties including large surface area, high porosity, surface charge, sustainability and low-cost which are beneficial in various fields, such as the remediation of polluted environments, soil amendments, wastewater treatment, and electrochemical sensors [1–3]. In this work, carbon paste electrode was bulk modified with biochar (BC-CPE) with the aim to develop a reliable electrochemical sensor for the determination of broad-spectrum fungicide mancozeb (MCZ) in wastewater sample.

## EXPERIMENTAL

The stock solution of MCZ (25.0 µg $mL^{-1}$) was prepared in 10% DMSO. Britton-Robinson (B-R) buffer was used as supporting electrolyte. BC from a hardwood source was synthesized *via* pyrolysis process at 400 °C (BC400) and 700 °C (BC700). Voltammetric measurements were performed on an AUTOLAB PGSTAT 12 (Ecochemie, The Netherlands) operated *via* GPES 4.9 software. A three-electrode system was applied with an unmodified or BC-modified CPE as the working electrode, a saturated calomel electrode (SCE) as a reference, and a platinum wire as an auxiliary electrode.

## RESULTS AND DISCUSSION

An unmodified CPE, BC400-CPE and BC700-CPE were compared for MCZ sensing by cyclic voltammetry (CV). The highest current intensity of MCZ was obtained using BC700-CPE **(Fig. 1)**.

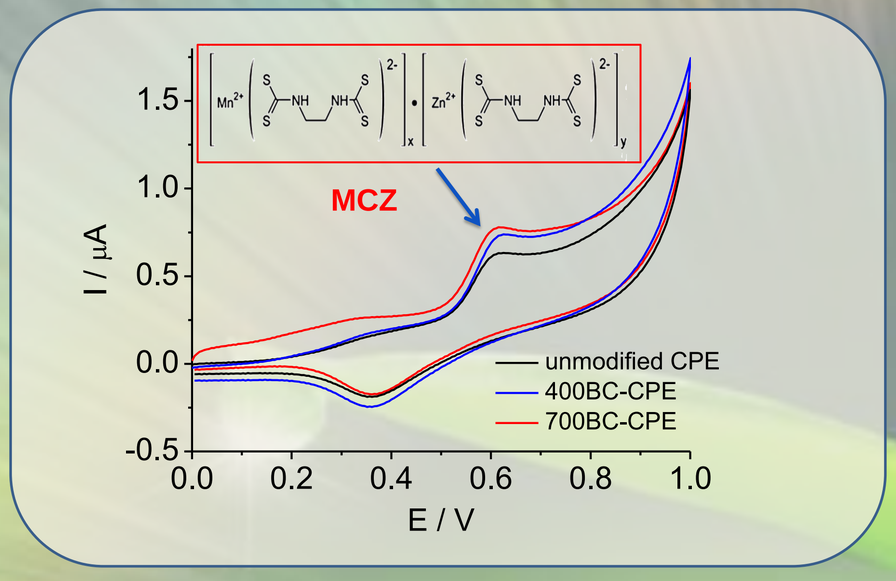


***Fig. 1. CV signals of MCZ (4.17 µg $mL^{-1}$) obtained by CPE, BC400-CPE and BC700-CPE at pH 7.0***

Under optimized conditions of differential pulse adsorptive stripping voltammetric (DPAdSV) method (pH 7.0, $E_{acc}$ = -0.2 V, $t_{acc}$ = 30 s) the obtained linear range was from 0.025 to 2.78 µg $mL^{-1}$ MCZ with detection limit of 7.5 ng $mL^{-1}$ **(Fig. 2)**.

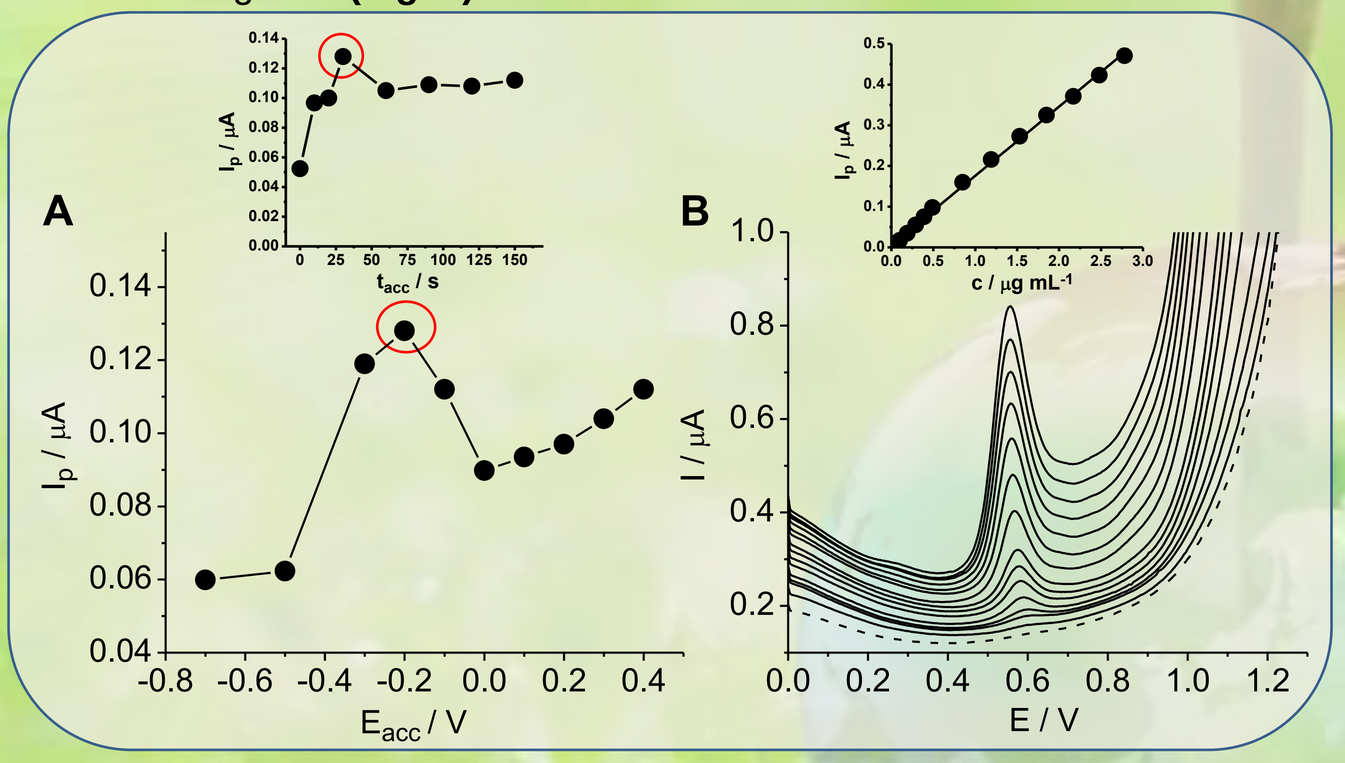


***Fig. 2. A) Influence of the $E_{acc}$ on the $I_p$ of 0.49 µg $mL^{-1}$ MCZ at $t_{acc}$ = 30 s. Inset: the effect of the $t_{acc}$ on the $I_p$ of MCZ ($E_{acc}$ = -0.2 V). B) DPAdSV curves obtained for increasing concentrations of MCZ with corresponding calibration curve. Supporting electrolyte: B-R buffer pH 7.0***

The developed sensor was successfully applied as a sensitive electrochemical platform for the determination of MCZ in wastewater sample **(Fig. 3)** with a recovery of 101.7% and a relative standard deviation of 1.25%.

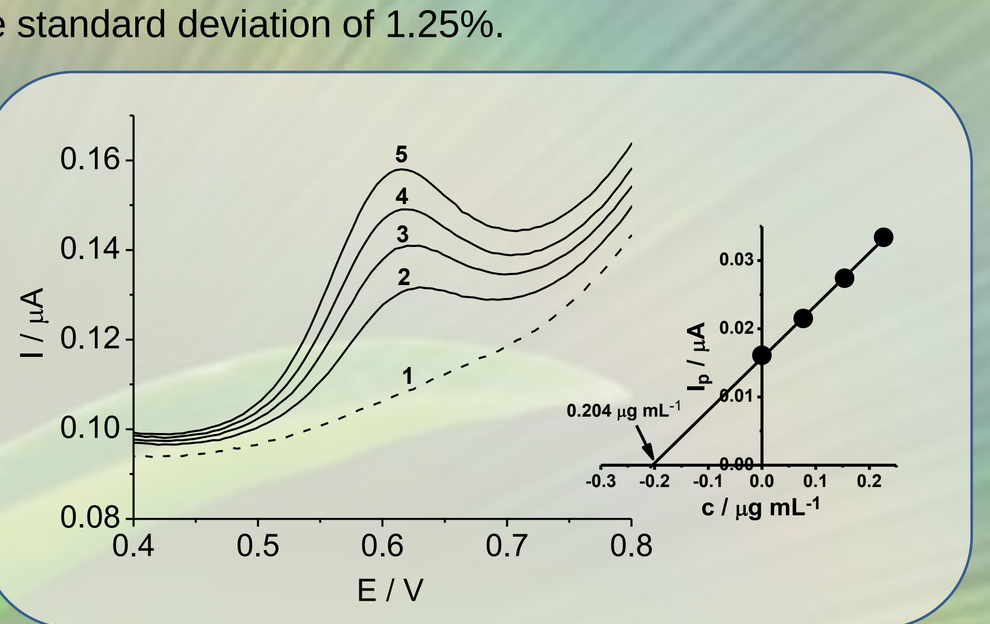


***Fig. 3. DPAdSV signals of MCZ determination by BC700-CPE in spiked wastewater sample using the standard addition method. The curves: (1) blank sample, (2) spiked sample and (3–5) successive MCZ standard additions. Corresponding analytical curve (inset)***

**References**

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