COMPARISON OF WHEAT AND CORN-DERIVED BIOCHAR AS MODIFIERS OF CARBON PASTE ELECTRODE FOR VOLTAMMETRIC DETERMINATION OF CARBENDAZIM

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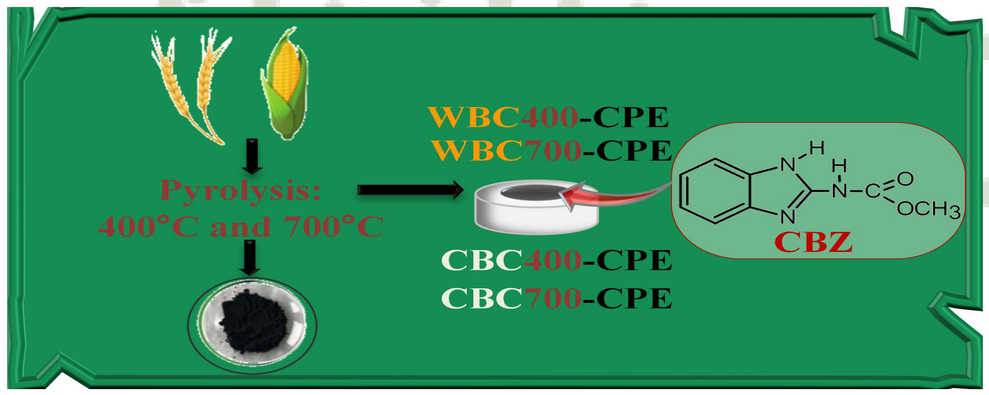
INTRODUCTION

Revealing the different types of biomass as low-cost resources with high availability is a way of exploring biochar (BC) potential for environmental waste management. BC, as a versatile and sustainable solution, can deal with various environmental pollutants, such as pesticides, in different environmental samples. The corn cob (CBC) and wheat straw (WBC)-derived BCs were used as carbon paste electrode (CPE) modifiers.

The aim of this study was to observe the electrochemical behavior of broad-spectrum fungicide carbendazim (methyl-1H-benzimidazol-2-yl-carbamate, CBZ) using designed BC-modified CPEs.



EXPERIMENTAL

The analytical standard of CBZ (Dr. Ehrenstorfer GmbH, Germany, purity 99.6%) was dissolved in methanol (Sigma-Aldrich).

Voltammetric measurements were performed on potentiostat/galvanostat/impedance analyzer Metrohm DropSens µStat-i 400s using DropView 8400 software. The voltammetric cell included a three-electrode system with a BC-CPE (10 wt% of BC in CPE) as the working electrode, a saturated calomel electrode as a reference, and a platinum auxiliary electrode.

Britton-Robinson (B-R) buffer was used as a supporting electrolyte.

The corn cob (CBC) and wheat straw (WBC)-derived biochars were synthesized at two pyrolysis temperatures, 400 °C (BC400) and 700 °C (BC700). The prepared BCs were characterized by scanning electron microscopy (SEM).

The electrochemical performance of the prepared BC-CPEs was evaluated by electrochemical impedance spectroscopic (EIS) and cyclic voltammetric (CV) measurements of the redox couple $[Fe(CN)_6]^{3-/4-}$.

RESULTS AND DISCUSSION

According to the SEM results (Fig. 1), pyrolysis temperature and biomasses type significantly affected the morphology of the CBC and WBC. WBC700 showed a more defined, porous structure with larger fragments, which led to good electrocatalytic properties, and consequently is considered as material for CPE modification.

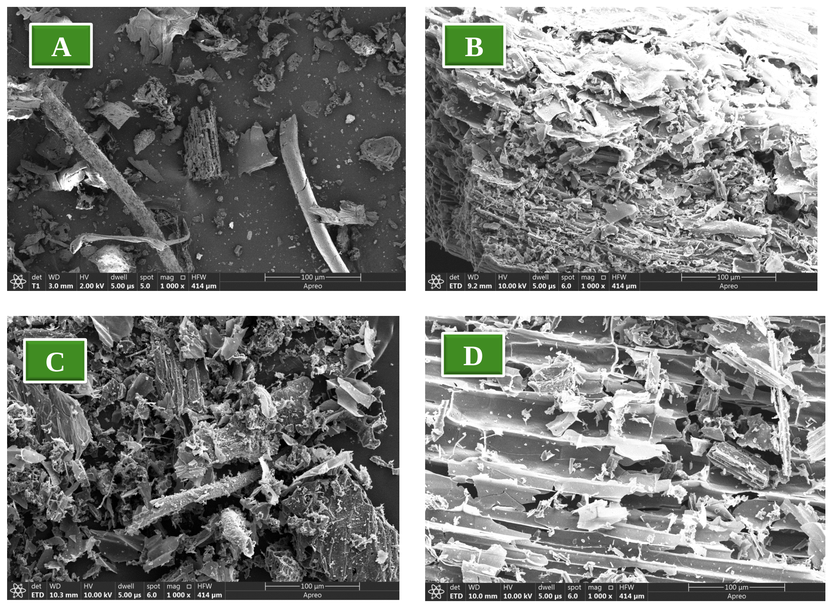


Fig. 1. SEMs of CBC400 (A), CBC700 (B), WBC400 (C), WBC700 (D) surfaces obtained at the magnification of 1000x

The electrochemical response is influenced by used modifiers, and the WBC700-CPE produced the lowest peak separation value and the highest peak currents of redox probe (Fig. 2A), as well as the lowest electron transfer resistance (Fig. 2B), and concomitantly the most pronounced improvement in charge transfer kinetics compared to the unmodified CPE, CBC400-CPE, CBC700-CPE and WBC400-CPE.

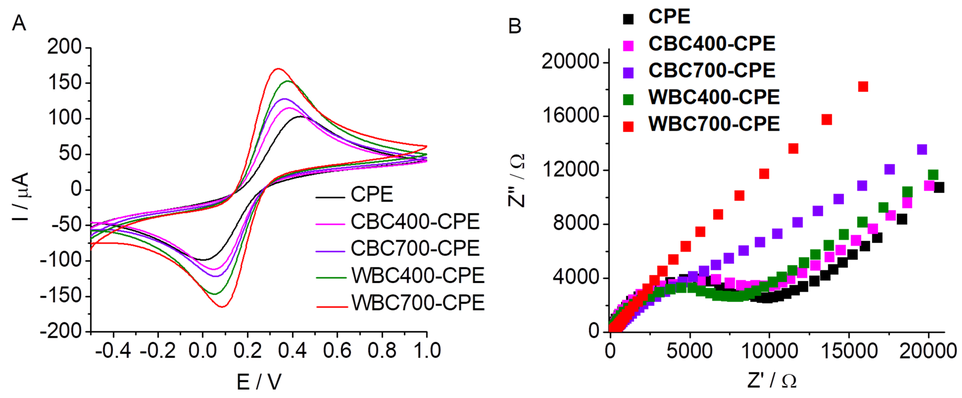


Fig. 2. CVs (v = 100 mV s^{-1}) (A) and EIS diagrams (B) of 0.01 mol L^{-1} $[Fe(CN)_6]^{3-/4-}$ in 0.5 mol L^{-1} Na_2SO_4, recorded with unmodified CPE and CPEs modified with 10% of different BCs (CBC400, CBC700, WBC400 and WBC700)

CV experiments (Fig. 3) showed that CBZ exhibits an irreversible behavior with a well-defined oxidation peak around 0.9 V at pH 5.0.

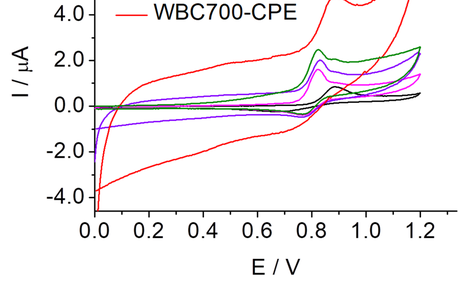


Fig. 3. CVs of CBZ (4.76 µg mL^{-1}) obtained using unmodified CPE and CPEs modified with 10% of different BCs (CBC400, CBC700, WBC400 and WBC700), v=100 mV s^{-1}

WBC700-CPE exhibits good catalytic activity and electron transfer ability.

WBC700-CPE showed the most favorable interactions with the CBZ.

Possibility for monitoring of CBZ in food and environmental samples.

ACKNOWLEDGEMENTS

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