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BOOK OF ABSTRACTS

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Karakaj 34a, 75 400 Zvornik
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e-mail: sekretar@tfzv.ues.rs.ba
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CARBON PASTE ELECTRODE MODIFIED WITH BIOCHAR FOR SENSITIVE ELECTROCHEMICAL DETERMINATION OF CARBENDAZIM IN ENVIRONMENTAL WATER SAMPLES

Jasmina Anojčić[1*], Sanja Mutić[1], Nina Đukanović[1], Tamara Apostolović[1], Tijana Marjanović Srebro[1], Jelena Beljin[1]

[1] *University of Novi Sad, Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental Protection, Trg Dositeja Obradovića 3, Novi Sad, Serbia, jasmina.anojcic@dh.uns.ac.rs**

Abstract

Electrochemical sensing is considered one of the most relied upon non-destructive, commercially viable, and effective techniques for the rapid, sensitive, and on-site detection of pesticides. Recently, as a member of the carbon family, biochar (BC) has been increasingly of interest to researchers. BC properties can be utilized for electrode construction and fabricating cost-effective sensors for different target compounds. Since persistent organic pollutants accumulate in the environment and have potential toxicity, there is a requirement to develop selective and sensitive analytical methods such as voltammetric ones for the detection of low-concentration levels of persistent and frequently used pesticides in the environmental water samples. Herein, wheat-derived BC was used for bulk-modification of carbon paste electrode (CPE) to prepare simple and sensitive electrochemical sensor for a systemic broad-spectrum fungicide carbendazim (CBZ). Various parameters were optimized to access the best electroanalytical performance of the sensor, including the electrode composition, pH of the supporting electrolyte and adsorption parameters. The amount of BC in CPE ranged from 0 to 30 wt%, and the most pronounced oxidation signal of CBZ was obtained using 5% BC-CPE. The effect of the pH (2.0–11.98) of Britton-Robinson buffer on the shape and intensity of CBZ signal was also investigated, whereby the pH 6.0 was selected as optimal. Since the adsorption plays a significant role in the oxidation mechanism of CBZ, additional studies were performed using square wave adsorptive stripping voltammetry (SW-AdSV) regarding the optimization of accumulation potential (E_{acc}) and accumulation time (t_{acc}) of the target analyte on the electrode surface. Under optimized conditions (E_{acc}=-0.2 V, t_{acc}=60 s, pH 6.0), the BC-based CBZ sensor exhibits a linear concentration range from 1.25 to 50.0 ng mL^{-1} with a limit of detection 0.38 ng mL^{-1} and relative standard deviation lower than 2.5%. The practical applicability of the 5% BC-CPE was examined for the determination of CBZ in environmental water samples such as surface water and wastewater. The good recovery and reproducibility confirm the potential of the proposed BC-based sensor for the rapid and reliable determination of pesticides in contaminated water, offering a sustainable alternative to traditional methods.

Keywords: *carbendazim, biochar, carbon paste electrode, square wave adsorptive stripping voltammetry, surface water, wastewater.*

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

Sanja Mutić[1*], Jasmina Anojčić[1], Nina Đukanović[1], Tamara Apostolović[1], Tijana Marjanović Srebro[1], Jelena Beljin[1]

[1] *University of Novi Sad, Faculty of Sciences, Department of Chemistry, Biochemistry and Environmental Protection, Trg Dositeja Obradovića 3, Novi Sad, Serbia, sanja.mutic@dh.uns.ac.rs**

Abstract

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 (CBC) and wheat (WBC)-derived biochars were synthesized at two pyrolysis temperatures, 400 °C (BC400) and 700 °C (BC700), and characterized using scanning electron microscopy (SEM). The effect of pyrolysis temperature on BC surface structure was recognized by the distinct difference in the morphology of CBC and WBC. Observed properties of the synthesized BCs led to a possibility for good electrocatalytic properties, which consequently are considered as possible material for modification of carbon paste electrode (CPE) comprised of graphite powder and paraffin oil. The electrochemical performance of the prepared BC-CPEs was evaluated by electrochemical impedance spectroscopic (EIS) and cyclic voltammetric (CV) measurements of the redox couple $[Fe(CN)_6]^{3-/4-}$. BC positively affects the electrochemical performance of the electrodes, which is attributed to an increase in the current intensity of the redox peaks, and to better reversibility due to the higher electron transfer rate. The electrochemical response is influenced by used modifiers in depending of conductivity of the electrode surfaces, and the WBC700-CPE produced the lowest peak separation value and the highest peak currents of redox probe compared to the unmodified CPE, CBC400-CPE, CBC700-CPE and WBC400-CPE. The observed electrochemical behavior of designed BC-modified CPEs suggests the ability to detect electroactive analytes such as broad-spectrum fungicide carbendazim (methyl-1H-benzimidazol-2-yl-carbamate, CBZ) deemed as a persistent organic pollutant. CV experiments showed that CBZ exhibits an irreversible behavior with a well-defined oxidation peak around 0.9 V at pH 5.0. Among the tested working electrodes for CBZ sensing, WBC700-CPE showed the most favorable interactions with the target analyte. The obtained results emphasize the enormous potential and bright future of WBC700-CPE with good catalytic activity and electron transfer ability for sensitive electroanalytical determination of CBZ in food and various environmental samples.

Keywords: *persistent organic pollutant, carbendazim, electrochemical sensor, carbon paste electrode, biochar, voltammetry.*

Acknowledgment: *This research was supported by the Science Fund of the Republic of Serbia, #10810, Sustainable solutions in environmental chemistry: exploring biochar potential–EnviroChar.*