PRO20.1. BioCompWaterClean: OD BILJNOG BIO-OTPADA DO NOVIH MATERIJALA I ODRŽIVOG PROCESA PREČIŠĆAVANJA OTPADNIH VODA

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Zagađenje voda predstavlja jedan od ključnih globalnih ekoloških izazova. Projekat BioCompWaterClean usmeren je na primenu biljnog biootpada u dizajnu i razvoju novih materijala za prečišćavanje otpadnih voda, u skladu sa principima zelene hemije i tehnologije i cirkularne ekonomije.

U okviru projekta razvijeni su biofunkcionalizovani kompozitni materijali na bazi magnetnih geopolimera, koji su primenjeni kao adsorbensi i katalizatori za uklanjanje fenolnih jedinjenja i jona metala iz vode. Biofunkcionalizacija se odvija *in situ*, tokom sinteze kompozita u prisustvu biljnih ekstrakata. Za tu namenu korišćeni su ekstrakti dobijeni iz kore jabuke, limuna i mandarine, kao i ljuske crnog luka, primenom ekstrakcije vodom u subkritičnom stanju, ultrazvučne i mikrotalasne ekstrakcije, kao i maceracije prirodnim eutektičkim rastvaračima. Bioaktivne komponente ekstrakata, pre svega polifenoli, doprinose modifikaciji površine materijala i povećanju njegove funkcionalnosti, čime se stvaraju povoljni uslovi za kovalentnu imobilizaciju enzima peroksidaze i dobijanje stabilnih biokatalizatora.

Dobijeni biokatalizatori pokazali su visoku enzimsku aktivnost, stabilnost i mogućnost ponovne upotrebe. Njihovom primenom ostvareno je uklanjanje fenola i hlorovanih derivata sa efikasnošću većom od 90%, uključujući i realne uzorke otpadnih voda. Biofunkcionalizovani magnetni geopolimeri pokazali su potencijal i u Fenton procesima, kao i za uklanjanje jona mangana (85-96%). Biološko ispitivanje primenom *Allium cepa* testa pokazalo je značajno smanjenje toksičnosti (za 34%) tretiranih uzoraka vode, što potvrđuje potencijal razvijenih materijala za primenu u održivim procesima prečišćavanja otpadnih voda.

Zahvalnica

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PRO20.1. BioCompWaterClean: FROM PLANT BIOWASTE TO NOVEL MATERIALS AND SUSTAINABLE WASTEWATER TREATMENT

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Water pollution represents one of the key global environmental challenges. The BioCompWaterClean project focuses on the use of plant-derived biowaste in the design and development of novel materials for wastewater treatment, in accordance with the principles of green chemistry and technology and the circular economy.

Within the project, biofunctionalized composite materials based on magnetic geopolymers were developed and applied as adsorbents and catalysts for the removal of phenolic compounds and metal ions from water. Biofunctionalization takes place *in situ* during composite synthesis in the presence of plant extracts. For this purpose, extracts obtained from apple, lemon, and mandarin peels, as well as onion skins, were prepared using subcritical water extraction, ultrasound-assisted extraction, microwave-assisted extraction, and maceration with natural deep eutectic solvents. The bioactive components of the extracts, primarily polyphenols, contribute to surface modification of the materials and enhancement of their functionality, thereby providing favorable conditions for the covalent immobilization of peroxidase and the production of stable biocatalysts.

The resulting biocatalysts demonstrated high enzymatic activity, stability, and reusability. Their application enabled the removal of phenols and chlorinated derivatives with efficiencies exceeding 90%, including from real wastewater samples. The biofunctionalized magnetic geopolymers also demonstrated potential for use in Fenton processes, as well as for the removal of manganese ions (85–96%). Biological testing using the *Allium cepa* assay demonstrated a significant reduction in the toxicity of the treated water samples (34%), confirming the potential of the developed materials for application in sustainable wastewater treatment processes.

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