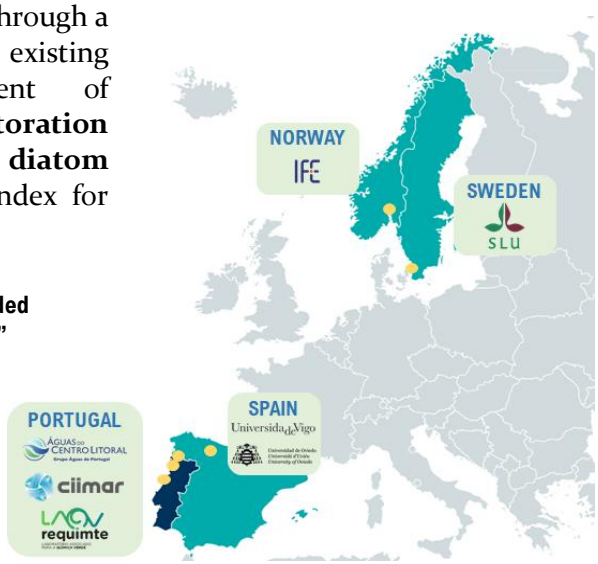
Newsletter 2

January 2024

Biodiversity restoration and conservation of inland water ecosystems for environmental and human well-being

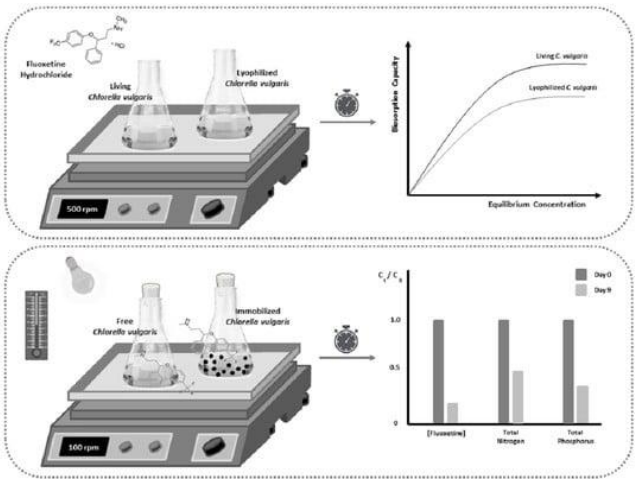
BioReset promotes **ecosystem recovery and conservation** through a combined approach including cutting-edge advances in existing **wastewater treatment processes** and development of **methodologies to assess ecosystem conservation and restoration** provided by these treatments based on investigating **diatom communities**, laying the foundation for a global quality index for ecological status and ecosystem assessment.



2020 – 2021 Joint COFUND Call on "Conservation and restoration of degraded ecosystems and their biodiversity, including a focus on aquatic systems"

Main results April 2022 – December 2023

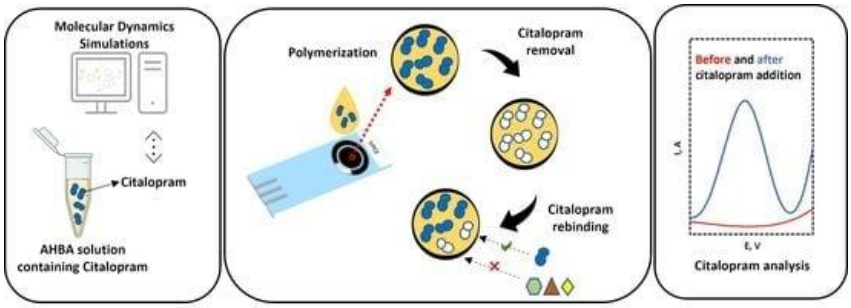
Fluoxetine and Nutrients Removal from Aqueous Solutions by Phycoremediation Int. J. Environ. Res. Public Health 2022, 19(10), 6081; https://doi.org/10.3390/ijerph19106081



The tertiary treatment using microalgae offers an attractive alternative to the removal of low but relevant concentrations of pharmaceuticals from domestic wastewaters. The removal of fluoxetine from aqueous solutions by living and non-living (lyophilized) Chlorella vulgaris was assessed. The determination of the pH at the point of zero charge, Fourier transmittance infrared analysis, and scanning electron microscopy were performed to characterize the microalgae biomass. Kinetic and equilibrium experiments were performed. The pseudo-second-order model described the kinetics of fluoxetine. The corresponding kinetic constants indicated that biosorption was faster onto non-living biomass than onto living biomass. The equilibrium results showed that the systems followed the Langmuir isotherm model. The maximum capacity of living microalgae (1.9 ± 0.1 $mg \cdot g^{-1}$) was slightly higher than the non-living microalgae (1.6 ± 0.2 $mg \cdot g^{-1}$). Living Chlorella vulgaris, free and immobilized in calcium-alginate, were also used to remove fluoxetine and nutrients (nitrogen and phosphorus) from treated municipal wastewater in a batch system. In both experiments, fluoxetine was completely removed within six days. The total phosphorus (TP) and total nitrogen (TN) removal efficiencies achieved for free and immobilized cells were, null and 65.0 ± 0.1%, and 86.2 ± 0.1% and 81.8 ± 3.1, respectively.

Computational Modelling and Sustainable Synthesis of a Highly Selective Electrochemical MIP-Based Sensor for Citalopram Detection

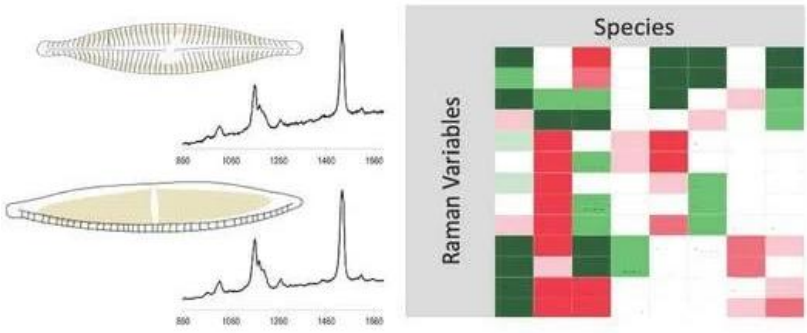
Molecules 2022, 27(10), 3315; https://doi.org/10.3390/molecules27103315



A novel molecularly imprinted polymer (MIP) has been developed based on a simple and sustainable strategy for the selective determination of citalopram (CTL) using screen-printed carbon electrodes (SPCEs). The MIP layer was prepared by electrochemical in situ polymerization of the 3-amino-4 hydroxybenzoic acid (AHBA) functional monomer and CTL as a template molecule. To simulate the polymerization mixture and predict the most suitable ratio between the template and functional monomer, computational studies, namely molecular dynamics (MD) simulations, were carried out. During the experimental preparation process, essential parameters controlling the performance of the MIP sensor, including CTL:AHBA concentration, number of polymerization cycles, and square wave voltammetry (SWV) frequency were investigated and optimized. The electrochemical characteristics of the prepared MIP sensor were evaluated by both cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) techniques. Based on the optimal conditions, a linear electrochemical response of the sensor was obtained by SWV measurements from 0.1 to 1.25 μmol L^{-1} with a limit of detection (LOD) of 0.162 μmol L^{-1} (S/N = 3). Moreover, the MIP sensor revealed excellent CTL selectivity against very close analogues, as well as high imprinting factor of 22. Its applicability in spiked river water samples demonstrated its potential for adequate monitoring of CTL. This sensor offers a facile strategy to achieve portability while expressing a willingness to care for the environment.

Novel Approach to Freshwater Diatom Profiling and Identification Using Raman Spectroscopy and Chemometric Analysis

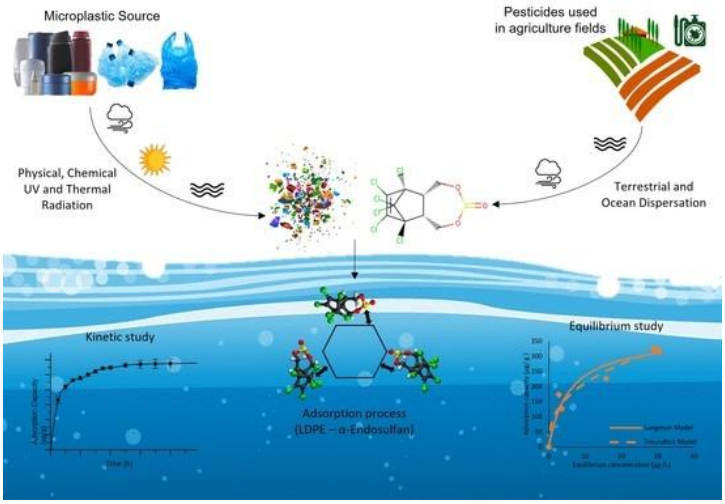
Water 2022, 14(13), 2116; https://doi.org/10.3390/w14132116



An approach with great potential for fast and cost-effective profiling and identification of diatoms in lake ecosystems is presented herein. This approach takes advantage of Raman spectroscopy. (2) The study was based on the analysis of 790 Raman spectra from 29 species, belonging to 15 genera, 12 families, 9 orders and 4 subclasses, which were analysed using chemometric methods. The Raman data were first analysed by a partial least squares regression discriminant analysis (PLS-DA) to characterise the diatom species. Furthermore, a method was developed to streamline the integrated interpretation of PLS-DA when a high number of significant components is extracted. Subsequently, an artificial neural network (ANN) was used for taxa identification from Raman data. (3) The PLS interpretation produced a Raman profile for each species reflecting its biochemical composition. The ANN models were useful to identify various taxa with high accuracy. (4) Compared to studies in the literature, involving huge datasets one to four orders of magnitude larger than ours, high sensitivity was found for the identification of Achnanthidium exiguum (67%), Fragilaria pararumpens (67%), Amphora pediculus (71%), Achnanthidium minutissimum (80%) and Melosira varians (82%)

Study of the Potential Accumulation of the Pesticide Alpha-Endosulfan by Microplastics in Water Systems

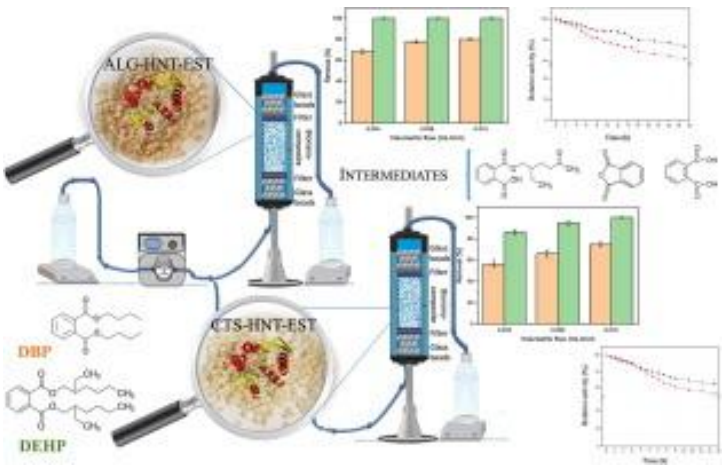
Polymers 2022, 14(17), 3645; https://doi.org/10.3390/polym14173645



Microplastics (MP) are spread into all ecosystems and represent a threat to the equilibrium of the environment and human health, not only due to their intrinsic characteristics but also to their action as effective carriers of contaminants, such as pesticides, pharmaceuticals, polychlorinated biphenyls and polycyclic aromatic hydrocarbons. The pesticide α-endosulfan is persistent and spread in the environment. The MP are another possible way of dissemination to be considered in the fate of this pesticide. The adsorption dynamics of α-endosulfan by six different MP (low-density polyethylene—LDPE, polyethylene-co-vinyl acetate, unplasticized polyvinyl chloride, polyamide 6, polystyrene granule, polypropylene granule) with different sizes/shapes and chemical compositions were evaluated. The most critical situation was identified for the system LDPE (particle size < 300 µm). Equilibrium studies (48 h equilibrium time) were performed for distilled, tap and filtered river water. Based on the Langmuir model parameters, the highest maximum adsorption capacity was obtained for distilled water, followed by filtered river and tap waters (i.e., 366 ± 39, 247 ± 38, 157 ± 22 µg/g). The obtained results demonstrate the important role that microplastics may have in the fate and transport of pesticides and their potentially harmful effect on the environment, which requires further investigation

Continuous treatment of diethyl hexyl and dibutyl phthalates by fixed-bed reactor: Comparison of two esterase bionanocomposites

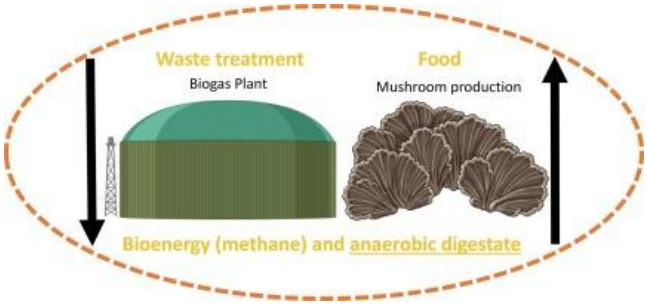
Bioresour. Technol. 2022, 363, 127990; https://doi.org/10.1016/j.biortech.2022.127990



The removal of Diethyl hexyl phthalate (DEHP) and Dibutyl phthalate (DBP) is of great importance due to their potential adverse effects on the environment and human health. In this study, two bionanocomposites prepared by immobilization of Bacillus subtilis esterase by crosslinking to halloysite and supported in chitosan and alginate beads were studied and proposed as a green approach. The esterase immobilization was confirmed by physical–chemical characterization. Bionanocomposite using chitosan showed the best degradation levels in batch tests attaining complete degradation of DBP and around 90% of DEHP. To determine the operational stability and efficiency of the system, two fixed bed reactors filled with both bionanocomposites were carried out operating in continuous mode. Chitosan based bionanocomposite showed the best performance being able to completely remove DBP and more than 85% of DEHP at the different flowrates. These results proved the potential of these synthesized bionanocomposites to effectively remove Phthalic Acid Esters.

Production of oyster mushroom (*Pleurotus ostreatus*) on sawdust supplemented with anaerobic digestate

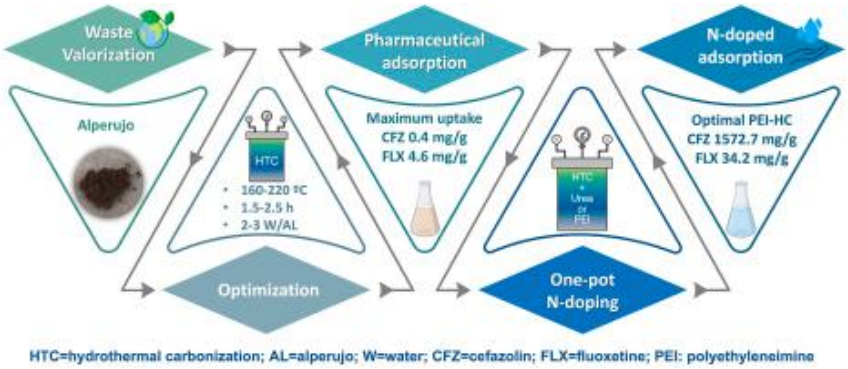
Waste Management 2023, 155, 1-7; https://doi.org/10.1016/j.wasman.2022.10.025



Anaerobic digestion of organic waste results in production of biogas and a nutrient-rich digestate that has an established use as fertilizer in plant production. This study evaluated use of anaerobic digestate based on a high concentration of organic household waste as a fertilizer in sawdust-based production of oyster mushrooms (Pleurotus ostreatus). Inclusion of 0.5 L of anaerobic digestate (AD) per kg sawdust gave similar productivity in terms of biological efficiency (79.5 ± 5.4 %), and protein concentration (24.7 ± 2.4 % of dry weight (dw)) as standard mushroom substrate (78.1 ± 5.3 %, and 21.9 ± 3.0 % of dw, respectively). However, mushroom growth was impaired at the highest concentration of anaerobic digestate tested, 1 L digestate per kg dw sawdust. Comparison of the AD-fertilized substrate with a mushroom substrate with standard components (sawdust, wheat bran, calcium sulfate) and with similar C/N-ratio revealed some differences in elemental composition of the fruiting bodies, with an major increase in sodium concentration for the AD-fertilized substrate compared with the standard substrate (413.3 ± 28.9 and 226.7 ± 30.6 mg kg^{-1} dw, respectively). This difference can be explained by high sodium concentration in the anaerobic digestate, most likely due to inclusion of food scraps from households and restaurants in the biodigester feedstock. Screening of both substrates for a total of 133 micropollutants revealed that total sum of micropollutants was significantly higher in the AD-fertilized substrate (258 ± 12 ng/g dw substrate) than in the standard substrate (191 ± 35 ng/g dw substrate). Nitrogen losses during preparation of the AD-fertilized substrate were negligible.

Facile one-step synthesis of a versatile nitrogen-doped hydrochar from olive oil production waste, "alperujo", for removing pharmaceuticals from wastewater

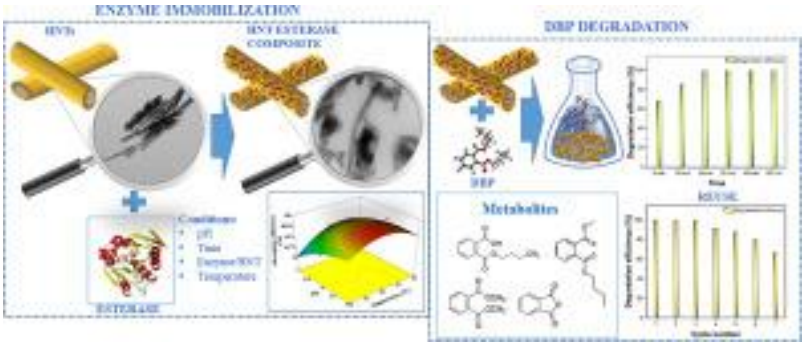
Environ. Pollut. 2023, 330, 1217551; https://doi.org/10.1016/j.envpol.2023.121751



In line with the principles of zero waste and recycling, alperujo (AL) was used in this study to produce a value-added product: hydrochar (HC) with high adsorption capacity. An optimization of the hydrothermal carbonization (HTC) conditions, such as temperature, residence time, and water/solid ratio, was carried out to maximize the adsorption capacity. Eight HCs were obtained, and an in-depth comparative characterization, as well as adsorption tests of two pharmaceuticals with very different physicochemical properties (fluoxetine (FLX) and cefazolin (CFZ)), were performed. This first step allowed for elucidation of the best candidates to carry out nitrogen grafting on their surface, resulting in the HC obtained at a higher water/solid ratio and temperature, and longer residence time: 3-220°C-2.5 h with a maximum uptake of 4.6 and 0.4 mg/g for FLX and CFZ, respectively. After that, a facile one-step, one-pot synthesis of nitrogen-doped hydrochars (N-HC) was developed to prepare a versatile bio-adsorbent with enhanced adsorption capacity. Two N–HCs were prepared using urea (U-HC) and polyethyleneimine (PEI-HC) and were intensively characterized to shed light on the adsorption mechanism. In both cases, amide groups were formed, which favored the adsorption process. PEI-HC acquired an outstanding maximum adsorption capacity of 983.84 mg/g for CFZ, and 29.31 mg/g for FLX, and the process was well described by the Freundlich isotherm and pseudo-second-order kinetic model. A co-adsorption test was performed using PEI-HC for both pharmaceuticals, finding that the adsorption process occurs in different active sites because there was no interference between the pollutants. This fact corroborates the versatility of the new bio-adsorbent synthesized.

Immobilization of esterase from *Bacillus subtilis* on Halloysite nanotubes and applications on dibutyl phthalate degradation

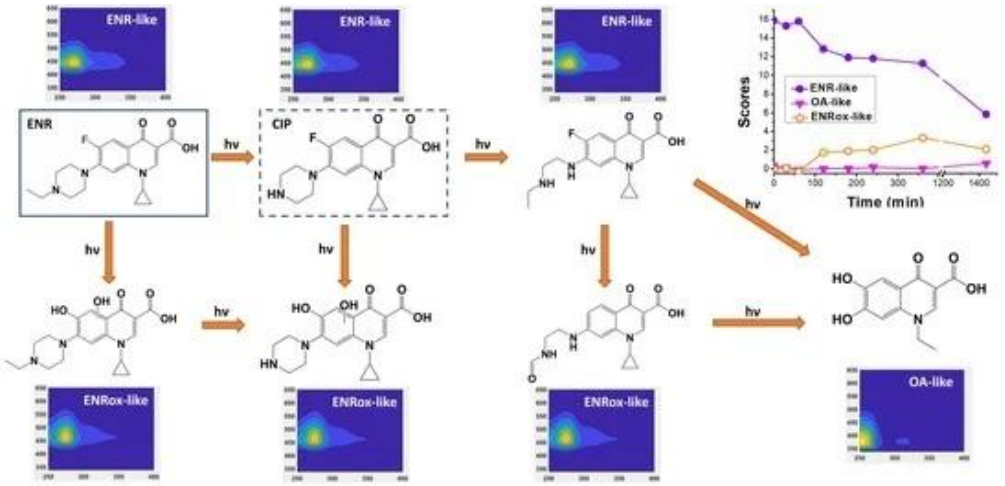
Environ. Technol. Inno. 2023, 30, 103113; https://doi.org/10.1016/j.eti.2023.103113



Dibutyl phthalate (DBP) is one of the listed phthalic acid esters (PAEs) known as the priority toxicants which exhibit carcinogenic and teratogenic properties and is responsible for endocrine disruption. Therefore, its removal has become a matter to tackle with. In this work, the feasibility of DBP degradation by esterase and lipase enzymes obtained from various microorganisms and the immobilization of the most effective in a clayey material were investigated. Esterase from Bacillus subtilis exhibited the highest degradation efficiency reaching a complete degradation. Its immobilization onto halloysite nanotubes (HNTs) by adsorption method was studied by response surface methodology using a central composite design face-centered. The four selected factors that affect the HNT-enzyme composite generation were: pH, adsorption time, enzyme/HNT (E/H) ratio, and adsorption temperature, and the optimal conditions were determined (pH 7, time 360 min, E/H ratio 0.2, temperature 30ºC). Consequently, the activity did not significantly decrease by immobilization, and the adsorption efficiency and relative activity were determined to be 73.15% and 82.7%, respectively. Besides, the immobilization enhanced thermal and storage stability. As for enzyme reusability, after 7 continuous cycles, the composite maintained almost 75% of its initial activity. Both the free enzyme (1 mg/mL) and the composite degraded 100 mg/L DBP with 100% efficiency and several byproducts were detected. Moreover, the composite could be reused for 7 cycles keeping a remarkable catalytic activity. Overall, this study indicated that the HNT-enzyme composite may be used as an effective candidate for remediation of the environmental media contaminated with DBP and other PAEs.

Use of Fluorescence Spectroscopy and Chemometrics to Visualise Fluoroquinolones Photodegradation Major Trends: A Confirmation Study with Mass Spectrometry

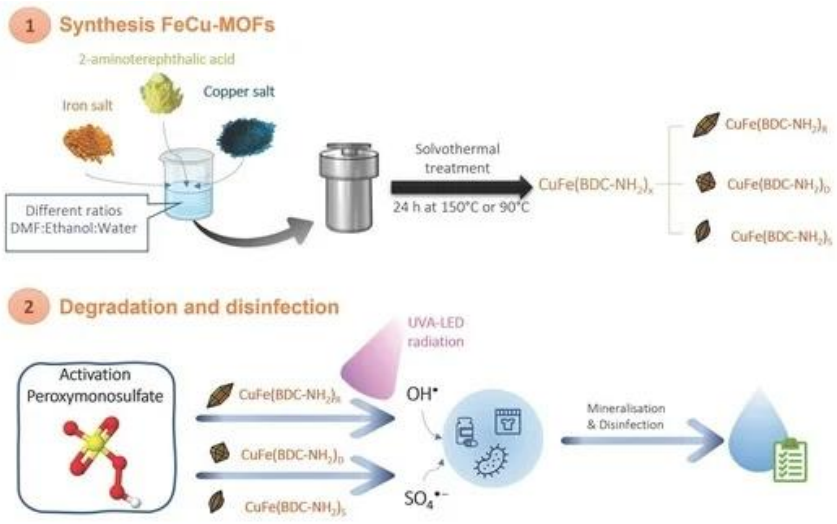
Molecules 2023, 28(2), 777; https://doi.org/10.3390/molecules28020777



In this work, we employed EEM-PARAFAC (fluorescence excitation-emission matrices-parallel factor analysis) as a low-cost tool to study the oxidation pathways of (fluoro)quinolones. Amounts of 12.5 µM of enrofloxacin (ENR), ciprofloxacin (CIP), ofloxacin (OFL), oxolinic acid (OA), and flumequine (FLU), as individual solutions, were irradiated under UVA light. A 5-component PARAFAC model was obtained, four of them related to the parent pollutants, named as ENR-like (including CIP), OFL-like, OA-like, and FLU-like, and an additional one related to photoproducts, called ENRox-like (with an emission red-shift with respect to the ENR-like component). Mass spectrometry was employed to correlate the five PARAFAC components with their plausible molecular structures. Results indicated that photoproducts presenting: (i) hydroxylation or alkyl cleavages exhibited fingerprints analogous to those of the parent pollutants; (ii) defluorination and hydroxylation emitted within the ENRox-like region; (iii) the aforementioned changes plus piperazine ring cleavage emitted within the OA-like region. Afterwards, the five antibiotics were mixed in a single solution (each at a concentration of 0.25 µM) in seawater, PARAFAC being also able to deconvolute the fingerprint of humic-like substances. This approach could be a potential game changer in the analysis of (fluorescent) contaminants of emerging concern removals in complex matrices, giving rapid visual insights into the degradation pathways.

Peroxymonosulfate Activation by Different Synthesized CuFe-MOFs: Application for Dye, Drugs, and Pathogen Removal

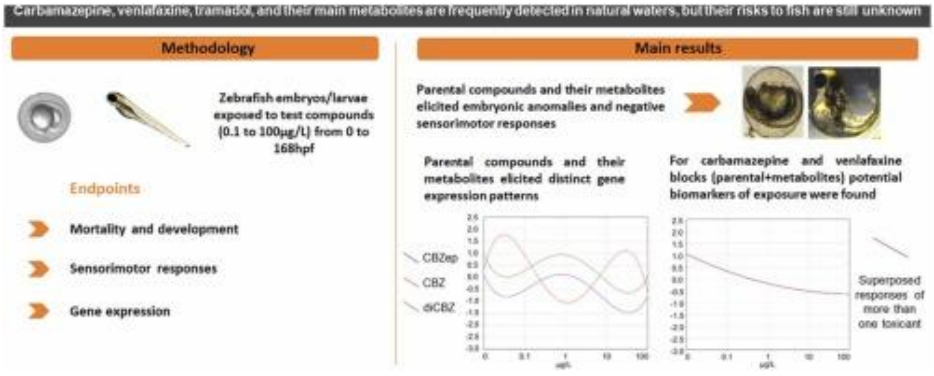
Catalysts 2023, 13(5), 820; https://doi.org/10.3390/catal13050820



In this study, three CuFe-MOFs were successfully synthesized by a solvothermal process by changing the ratio of solvents, salts, or temperature. These MOFs named CuFe(BDC-NH_2)$_R$, CuFe(BDC-NH_2)$_S$, and CuFe(BDC-NH_2)$_D$ showed rod-shaped, spindle-like, and diamond-like structures, respectively. The CuFe(BDC-NH_2)$_D$ and CuFe(BDC-NH_2)$_S$ were found to exhibit an improved PMS activation for Rhodamine B removal attaining levels around 92%. Their effective removal capability was investigated as a function of the pH, catalyst dosage, and the effect of the application of UV radiation. The best degradation system was photo-assisted activation of PMS when CuFe(BDC-NH_2)$_D$ and CuFe(BDC-NH_2)$_S$ were used. Under these conditions, the degradation of a mixture of antibiotic and anti-inflammatory drugs (sulfamethoxazole and antipyrine) was evaluated with the results revealing the total degradation of both drugs after 1 h. A higher antibacterial activity was attained with the system CuFe(BDC-NH_2)$_R$/PMS due to the high copper content with respect to the others.

Carbamazepine, venlafaxine, tramadol, and their main metabolites: Toxicological effects on zebrafish embryos and larvae

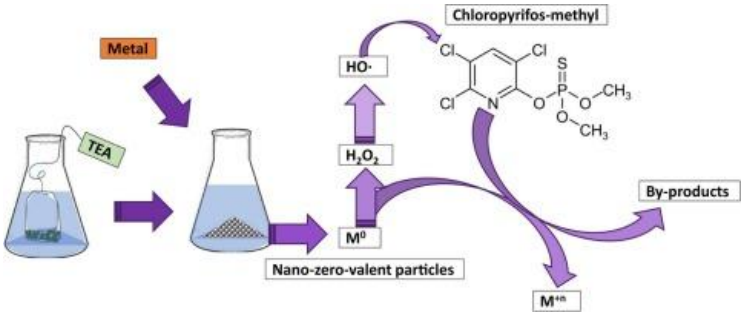
J. Hazard. Mater. 2023, 448, 130909; https://doi.org/10.1016/j.jhazmat.2023.130909



Pharmaceutical compounds and their metabolites are found in natural and wastewater. However, investigation of their toxic effects on aquatic animals has been neglected, especially for metabolites. This work investigated the effects of the main metabolites of carbamazepine, venlafaxine and tramadol. Zebrafish embryos were exposed (0.1—100 µg/L) for 168hpf exposures to each metabolite (carbamazepine-10,11-epoxide, 10,11-dihydrocarbamazepine, O-desmethylvenlafaxine, N-desmethylvenlafaxine, O-desmethyltramadol, N-desmethyltramadol) or the parental compound. A concentration-response relationship was found for the effects of some embryonic malformations. Carbamazepine-10,11-epoxide, O-desmethylvenlafaxine and tramadol elicited the highest malformation rates. All compounds significantly decreased larvae responses on a sensorimotor assay compared to controls. Altered expression was found for most of the 32 tested genes. In particular, *abcc1, abcc2, abcg2a, nrf2, pparg* and *raraa* were found to be affected by all three drug groups. For each group, the modelled expression patterns showed differences in expression between parental compounds and metabolites. Potential biomarkers of exposure were identified for the venlafaxine and carbamazepine groups. These results are worrying, indicating that such contamination in aquatic systems may put natural populations at significant risk. Furthermore, metabolites represent a real risk that needs more scrutinising by the scientific community.

Nano-zero-valent particles synthesized with agroindustry wastes for pesticide degradation under real conditions

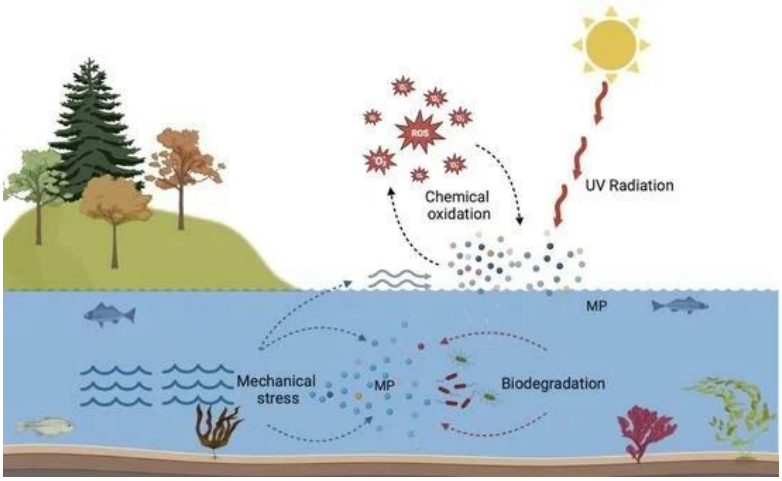
Process Saf. Environ. Prot. 2023, 176, 1089-1100; https://doi.org/10.1016/j.psep.2023.06.089



Nano-zero-valent particles (NZVP) had exhibited high degradation activity. NZVP synthesized from agroindustry residues align with circular economy principles. They generate hydroxyl radicals (4.6 μM) that effectively degraded chlorpyrifos-methyl pesticide under real conditions. Bimetallic NZVP, specifically NZVP-Fe:Mn and NZVP-Fe:Ag, show superior pesticide degradation. The metal ratio within NZVP influences their activity (optimal at 0.12:0.12 mM and 0.12:0.19 mM for respectively, NZVP-Fe:Mn and NZVP-Fe:Ag). NZVP characterization includes TEM, SEM-EDS, PZC, FTIR, XRD, and electrochemical analysis, confirming their acid nature, favorable electrochemical behavior, and uniform metal distribution. The impact of different natural extracts on NZVP synthesis and pesticide degradation was explained through extensive extract characterization, revealing the presence of altering pro-oxidants and scavenger species. Blueberry pruning extract yields the highest pesticide degradation (85% in 5 min) due to its stronger antioxidant activity and lower scavenger compound content. NZVP demonstrates efficacy across various pH ranges. Real wastewater samples were treated under optimal conditions, resulting in a pesticide degradation efficiency of approximately 60% within 5 min. The most effective approach for enhancing the treatment process involved the sequential addition of reagents, as opposed to the conventional method of increasing reagent concentration.

Laboratory Studies about Microplastic Aging and Its Effects on the Adsorption of Chlorpyrifos

Polymers 2023, 15(16), 3468; https://doi.org/10.3390/polym15163468



The constant change in microplastics (MP) due to exposure to environmental conditions leads to physical and chemical changes that enhance their ability to transport other pollutants, increasing the concern about their widespread presence in the environment. This work aimed to simulate the aging process of six MP (polyamide 6, unplasticized polyvinyl chloride, low-density polyethylene, polystyrene, polyethylene-co-vinyl acetate, polypropylene) in freshwater and seawater ecosystems at laboratory scale and evaluate its effects through optical microscope observation, Fourier transform infrared spectroscopy-Attenuated Total Reflectance (FTIR-ATR), Raman spectroscopy, and thermal gravimetric analysis (TGA). Through a combined experimental study of aged MP, the degradation by UV interaction was evidenced by the appearance of new infrared bands in the FTIR spectra assigned to ketones and hydroxyl groups. While Raman analysis and microscope images reveal the appearance of pores, wrinkles, and roughness in the MP surfaces. Variations in the temperature of the maximum weight loss of the MP were observed in the TGA analysis. The adsorption of chlorpyrifos (CPF), a common pesticide widely used in agriculture, by the pristine and aged MP was also studied. The highest affinity for CPF was observed for pristine LDPE and the lowest for PP. The batch adsorption studies revealed an increase in adsorption capacity as a consequence of the aging process for both MP. These results proved that the weathering effects caused changes in the behavior of MP, namely in the interaction with other pollutants.

Microplastic Pollution Focused on Sources, Distribution, Contaminant Interactions, Analytical Methods, and Wastewater Removal Strategies: A Review Int. J. Environ. Res. Public Health 2022, 19(9), 5610; https://doi.org/10.3390/ijerph19095610

Fluoxetine Removal from Aqueous Solutions Using a Lignocellulosic Substrate Colonized by the White-Rot Fungus Pleurotus ostreatus Int. J. Environ. Res. Public Health 2022, 19(5), 2672; https://doi.org/10.3390/ijerph19052672

Fluoride-Doped TiO_2 Photocatalyst with Enhanced Activity for Stable Pollutant Degradation Catalysts 2022, 12(10), 1190; https://doi.org/10.3390/catal12101190

Occurrence of Pharmaceutical and Pesticide Transformation Products in Freshwater: Update on Environmental Levels, Toxicological Information and Future Challenges Rev. Environ. Contam. Toxicol. 2022, 260, 14; https://doi.org/10.1007/s44169-022-00014-w

Application of Deep Eutectic Solvents (DES) for the Synthesis of Iron Heterogeneous Catalyst: Application to Sulfamethoxazole Degradation by Advanced Oxidation Processes Catalysts 2023, 13(4), 679; https://doi.org/10.3390/catal13040679

Molecularly Imprinted Plasmonic Sensors for the Determination of Environmental Water Contaminants: A Review Chemosensors 2023, 11(6), 318; https://doi.org/10.3390/chemosensors11060318

From Waste to Resource: Valorization of Lignocellulosic Agri-Food Residues through Engineered Hydrochar and Biochar for Environmental and Clean Energy Applications—A Comprehensive Review Foods 2023, 12(19), 3646; https://doi.org/10.3390/foods12193646

The Microplastics Iceberg: Filling Gaps in Our Understanding Polymers 2023, 15(16), 3356; https://doi.org/10.3390/polym15163356

Dissemination activities - Some conferences in which BIORESET results were share

News & Events in 2023

March - BioReset @ ISEP

The BioReset project was presented at the Department of Chemical Engineering - Instituto Superior de Engenharia do Porto (ISEP, Portugal)

March - BioReset in a Portuguese newspaper

The BioReset project was the subject of a report in País Positivo ("Positive Country").

CRISTINA DELERUE-MATOS, coordenadora do Grupo de Reação e Análises Químicas (GRAQ) do Instituto Superior de Engenharia do Porto (ISEP), integrado no Laboratório Associado para a Química Verde (LAQV) da Rede de Química e Tecnologia (REQUIMTE), apresenta o projeto ***BioReset*** que tem como foco o desenvolvimento de processos de remoção de fármacos e microplásticos de águas residuais para serem reutilizadas para rega, ao mesmo tempo "contribuir para a recuperação e conservação de ecossistemas."

Em que consiste o projeto *BioReset*?

As Estações de Tratamento de Águas Residuais (ETAR), não foram construídas para eliminar poluentes como fármacos ou microplásticos, pelo que muitos destes compostos e substâncias passam pelas ETAR sem sofrer qualquer transfor-

REQUIMTE - ISEP/BIORESET: PROJETO VISA REMOVER POLUENTES DAS ÁGUAS RESIDUAIS E REUTILIZAR A ÁGUA PARA REGA

A constituição do consórcio teve em consideração as diferentes competências e a experiência comprovada de cada equipa, em domínios complementares.

Em que fase de implementação se encontra o *BioReset*?

O *BioReset* arrancou há um ano.

A primeira etapa foi a validação dos métodos analíticos de forma a permitir identificar e quantificar os poluentes nos efluentes e avaliar a eficiência dos tratamentos.

As metodologias analíticas para controlo de fármacos estão bem estabelecidas no nosso grupo. Neste momento, estamos a desenvolver as metodologias para análise de microplásticos. Para esta família de poluentes, existem inúmeros métodos diferentes, e só a sua conjugação permite identificar os constituintes dos micro-plásticos.

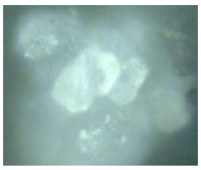
De que forma se vai alargando a lista de substâncias a serem avaliadas e monitorizadas, e como se desenvolve a estratégia ao nível dos tratamentos nas ETAR?

O ideal seria transformar os fármacos em dióxido de carbono e água, mas nem sempre se consegue atingir essa eficiência. Alguns tratamentos, nomeadamente os químicos, podem originar compostos intermédios mais tóxicos do que os de partida. Assim, ensaios de ecotoxicidade devem complementar o estudo. Se pensarmos que os fármacos foram desenvolvidos para tratar doenças, portanto com efeitos benéficos para a saúde humana, durante muito tempo não se associou qualquer problema à sua presença no ambiente. Hoje, os fármacos são considerados poluentes emergentes. Não estão incluídos na legislação, mas fazem parte da Lista de Vigilância das substâncias a monitorizar a nível da União Europeia no domínio da política da água.

Este projeto deseja ser mais ambicioso e pretende remover poluentes emergentes dos efluentes tratados. Estas substâncias aparecem em quantidades muito reduzidas, mas a sua acumulação pode causar efeitos danosos nos organismos vivos e, consequentemente, na saúde humana.

A nossa estratégia passa por desenvolver tratamentos sustentáveis, de forma a permitir elevado grau de segurança na utilização das águas das ETAR para rega.

A PRESENÇA DE MICROPLÁSTICOS NOS EFLUENTES TRATADOS, É OUTRA DAS PREOCUPAÇÕES DO *BIORESET*.



Poliamida 6 – imagem obtida por espetroscopia RAMAN.

Plásticos no oceano.

November - BioReset @ BranschDag Trädgård

The green bioremediation with white-rot fungi technology was presented in Alnarp (Sweden) on November 24, 2023 during the "BranschDag Trädgård" (Industry Day Garden).

Biodiversity restoration and conservation of inland water ecosystems for environmental and human well-being

News & Events in 2022

June - Borgeby Fältdagar

The BioReset project was presented during the "Borgeby Fältdagar" (Borgeby Field days, Sweden)

September - BioReset @ CIIMAR

Raquel Pinto presented "Diatoms: From Science to Art" in a stand at the Open day of CIIMAR

August - BioReset in International & Portuguese newspapers

The BioReset project was the subject of a news item published in several Portuguese and International newspapers.

Some examples:

BioReset

A Biodiversity Project

Norway, Portugal, Spain, Sweden

+info:

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