FROM WASTE TO RESOURCE: CONVERSION OF SEWAGE SLUDGE INTO BIOCHAR AND ITS CIRCULAR APPLICATION TO NATURE-BASED SOLUTIONS FOR WASTEWATER TREATMENT

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Abstract: Constructed wetlands (CWs) are nature-based solutions (NBS) for wastewater treatment characterized by low-cost, low environmental impact, and simple technology, which exploit removal mechanisms active in natural ecosystems and have proved to be very efficient for the removal of conventional water quality macroparameters. However, many organic micropollutants (OMPs) are often not removed in these systems unless hydraulic retention times of several days are used, thus making CWs not compatible with wastewater treatment requirements, which involve processing large volumes of wastewater in a few hours. This prevents the application of CWs as quaternary systems in the modern regulatory context provided by the recent revision of the European Directive "urban wastewater" and the legislation on the reuse of treated wastewater, both providing great attention to the elimination of OMPs, with particular reference to pharmaceutical compounds (PhCs) and personal care products. A possible solution to these problems is the use of alternative substrates to those traditionally used in CWs (e.g., sand and gravel), which can provide a larger surface area and are therefore able to (i) provide a greater adsorption capacity towards organic matter and ii) represent an ideal colonization support for microorganisms responsible for organic matter degradation, as well as for the implementation of nitrification and denitrification processes.
Based on the aforementioned considerations, this study aimed at investigating the removal efficiency of CWs integrated with biochar produced by co-pyrolysis of a sawdust-sewage sludge mixture 70/30 (w/w) and sewage sludge only. Various experimental conditions were tested for the production of the material and the biochars obtained were characterized for a number of parameters, such as specific surface area and porosity distribution, ash content, and release of inorganic and organic pollutants, according to the EN 12915-1 European Standards regulating the use of adsorbent materials for the treatment of drinking water. Production conditions suitable to obtain materials complying the aforementioned regulation were identified [1].
All CWs were fed for about eight months with real effluent wastewater from an activated sludge biological treatment operating in a mixed domestic-industrial textile context and providing treated wastewater for re-use purposes. CWs influent and effluent wastewaters were monitored for (i) conventional water quality parameters, (ii) absorbances at 254 nm and 420 mm, and (iii) thirty-nine PhCs introduced by 2015-2022 European "watch lists' and characterized by different physicochemical properties in terms of LogD. Biochar-based CWs provided a statistically significant improvement in the removal of chemical oxygen demand (COD, $\Delta\approx22\%$) and ammonia ($\Delta\approx35\%$), as well as in the reduction of UV-Vis absorbances ($\Delta\approx32$-34% and $\Delta\approx28\%$ for 254 and 420 nm, respectively), and PhCs, compared to gravel-filled microcosms, thus demonstrating the effectiveness of the sludge-based biochar as a standalone adsorbent for wastewater depuration from both conventional parameters and emerging contaminants |2].

References

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