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INTEGRATION OF BIOCHAR FROM CO-PYROLYSIS OF BIOLOGICAL SLUDGE AND SAWDUST IN VERTICAL FLOW CONSTRUCTED WETLANDS TREATING URBAN WASTEWATER

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Abstract *Constructed wetlands (CWs) are low-cost, low environmental impact, and simple-technology systems for wastewater treatment, 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 lab-scale vertical flow CWs (VF-CWs) filled with biochar produced by co-pyrolysis of a sawdust-sewage sludge mixture 70/30 (w/w), using systems filled with coarse sand, gravel, and cobblestones as control. All systems 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. VF-CWs influent and effluent wastewaters were monitored for (i) conventional water quality parameters, (ii) absorbances at 254 nm and 420 nm, and (iii) thirty-nine PhCs introduced by 2015-2022 European "watch lists" and characterized by different physicochemical properties (-0.4<LogP<10). Biochar-based VF-CWs provided a statistically significant improvement in the removal of chemical oxygen demand (COD, Δ≈22%) and ammonia (Δ≈35%), as well as in the reduction of UV-Vis absorbances (Δ≈32-34% and Δ≈28% 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.*

Keywords: Chemical Oxygen Demand, Ammonia, Nitrate, Organic Micropollutants, Agricultural Reuse.

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Biography: Massimo Del Bubba is Associate Professor of Analytical Chemistry at the Department of Chemistry of the University of Florence . He obtained his PhD in Environmental Sciences in 2000 and was enrolled as Assistant Professor at the University of Florence in 2001. He has published about 150 papers in journals indexed on Scopus that received about 5000 citations, with a H-Index of 38. His research interests range from analytical chemistry to environmental chemistry, with particular reference to the challenges related to the development of automatic high-throughput methods for the quantification of organic micropollutants in various environmental and food matrices and to their application for environmental monitoring, including that of wastewater treatment plants, both technological and "nature-based". Recently, he has also worked on the development of low-cost materials deriving from the thermal conversion of plant wastes and biosolids to be used as substrates in constructed wetlands.