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Treatment of olive mill and municipal wastewater mixture by a two-stage horizontal-flow constructed wetlands integrated with biochar: A preliminary study

M. Fichera¹, Z. Bakari¹, M. C. Bruzzoniti², L. Rivoira², D. Fibbi, F. Cioni and M. Del Bubba¹*

¹*Department of Chemistry “Ugo Schiff”, University of Florence, 50019 Sesto Fiorentino, Italy*

²*Department of Chemistry, University of Turin, 10125 Turin, Italy*

³*GIDA Gestione Impianti Depurazione Acque S.p.A., 59100 Prato*

⁴*ARPAT, Dipartimento Provinciale di Firenze, Via Ponte alle Mosse 211, 50144 Firenze, Italy*

** michelangelo.fichera@unifi.it*

Olive oil production in the Mediterranean generates large volumes of by-products—olive mill wastewater (OMWW), rich in organic and phenolic compounds, and olive mill solid waste (OMSW) - whose untreated discharge poses serious environmental risks. At the same time, municipal wastewater contains nutrients and persistent organic micropollutants (e.g., pharmaceuticals, per- and polyfluoroalkyl substances) that demand effective secondary treatment. Constructed wetlands (CWs) are recognized nature-based solutions for small-scale sewage polishing, but also for refining urban wastewater from larger treatment facilities¹, but their performance is hampered by low dissolved oxygen in the reed beds and limited sorption capacity of conventional substrates (sand, gravel). Recent studies have shown that integrating biochar and forced aeration can enhance contaminant adsorption and oxygen-dependent removal processes¹; however, high nitrate levels still require targeted denitrification.

In this preliminary study, we evaluated a pilot-scale two-stage system combining a horizontal-flow CW (HF-CW) filled with gravel. In the first stage, the HF-CW was operated under controlled aeration to maximize aerobic degradation, while the second stage was maintained under anoxic conditions to enhance denitrification and sorption of residual organics. As a further treatment, a vertical-flow filter unit filled with biochar (BC) produced by pyrolysis of OMSW has been implemented – valorising solid wastes within a sustainable framework. The engineered BC, properly activated, exhibited promising sorption properties (BET surface area = 604 m² g⁻¹). Over two months, real urban wastewater mixed with OMWW was treated at a hydraulic loading rate of 80 L m⁻² d⁻¹, monitoring several parameters affecting the quality of the wastewater, such as chemical oxygen demand (COD), the full nitrogen and phosphorus cycles, and UV absorbances at 254 nm and 420 nm) and total soluble polyphenols.

References

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