BIOCHAR FROM PYROLYSIS OF SEWAGE SLUDGE FOR THE REMOVAL OF STEROID HORMONES IN REAL WASTEWATER

M. Fichera[1], R. Guedes Alonso[2], J. J. Santana-Rodríguez[2], R. Camisa[3], D. Fibbi[3], M. Del Bubba[1]

[1] Department of Chemistry "U. Schiff", University of Florence, Via della Lastruccia 3, Sesto Fiorentino, 50019, Florence (Italy)
[2] Instituto Universitario de Estudios Ambientales y Recursos Naturales (i-UNAT), Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas de Gran Canaria, Spain
[3] Gestione Impianti di Depurazione Acque (G.I.D.A.) S.p.A., Via di Baciacavallo 36, Prato, 59100 (Italy)
michelangelo.fichera@unifi.it

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Abstract: Organic micropollutants (OMPs) from both industrial and domestic origin have significantly affected the quality of surface water and treated wastewater for reuse. Among these, pharmaceutical compounds represent a significant concern due to their widespread distribution and biological activity. Specifically, steroid hormones (SHs) pose a significant risk to aquatic ecosystems due to their disruptive effects[1]. Conventional wastewater treatment plants (WWTPs) are not designed to eliminate these pollutants[2], thus being a punctual source of pollution. Moreover, the issue of organic micropollutants (OMPs) in urban wastewater has recently been highlighted in a Proposal for a European Directive on urban wastewater treatment[3]. Among the technologies developed to remove OMPs from wastewater, adsorption techniques offer a promising approach due to their simplicity, eco-friendliness, and relatively low cost, especially if making use of sorbents derived from waste, as pictorially illustrated in Figure 1. For this reason, biochar produced from sewage sludge pyrolysis could represent a promising strategy to manage hazardous residues from WWTPs.
In this research, a two-step pyrolysis method was optimized to produce biochar with enhanced adsorption stability. The best-performing biochar, treated chemically and thermally, provided a surface area as high as 436 m^2g^{-1} and minimal water-leachable impurities. Maximum adsorption capacity (Q_m) for SHs were assessed in both ultrapure water and real wastewater matrices through kinetic and isotherm tests, using a commercial activated carbon (AC) as reference. Q_m values comparable to those determined for AC were observed. Using partial least squares (PLS) modelling, the Qm values provided insights into the possible adsorption mechanisms involved. To extend the biochar's usability, both chemical and thermal regeneration methods were tested, observing a dropping in removal rates up to 35% and 54%, respectively. Long-term tests were also conducted through in-column studies to evaluate the effectiveness of the biochar medium for practical applications.

Figure 1 – Graphical illustration of the circular approach to sewage sludge management and reuse in wastewater treatment plants.

References

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