SCI 2024
Chemistry
ELEMENTS OF FUTURE
XXVIII National Congress
MILANO,
26 - 30 August 2024
Società Chimica Italiana

ABC-OR-017

Two-step pyrolysis biochar from industrial sludge and its application for removal of steroid hormones from wastewater

M. Fichera[a], R. Guedes Alonso[b], J. J. Santana-Rodríguez[b], R. Camisa[c], D. Fibbi[c], M. Del Bubba[a]

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

The increasing prevalence of organic micropollutants (OMPs) from both industrial and domestic sources has significantly affected the quality of surface water and treated wastewater for reuse. Among these, pharmaceutical compounds pose a significant concern due to their widespread distribution and biological activity. Specifically, steroid hormones (SHs) have drawn growing interest in the scientific community for their disruptive effects on the endocrine system in aquatic organisms.[1] Wastewater treatment plants (WWTPs) are recognized as sources of these pollutants,[2] since they are not designed for their removal. Therefore, as recently remarked in a Proposal for an European Directive concerning urban wastewater treatment,[3] it is urgently needing to address the issue of OMPs in urban wastewater, especially for larger WWTPs. Among the technologies developed to remove OMPs from wastewater, physicochemical processes such as adsorption offer promising solutions due to their simplicity, eco-friendliness, and relatively low cost. As a potential adsorbent, biochar could represent a cost-effective and efficient solution. Furthermore, the biochar production from sewage sludge pyrolysis could represent a promising strategy to manage hazardous residues from WWTPs.

Based on the aforementioned considerations, this work used a two-step pyrolysis methodology to produce biochar on a bench-scale with improved adsorption stability by removing tar produced during pyrolysis and mineral components, that are intrinsic to this waste, so as to reach the highest removal of different categories of SHs. For this purpose, physicochemical properties of various biochars produced in our laboratory were investigated. The best material, subjected to a chemical and subsequent thermal treatment, provided a remarkable surface area (436 m^2 g^{-1}), together with a high environmental compatibility in terms of water leachable impurities. Maximum adsorption capacity (Q_m) for SHs were assessed in real wastewater matrices through kinetic and isotherm tests, using a commercial activated carbon (AC) as reference. Q_m values 2.5-1.1 lower than those of AC were observed, (except for Estrone for which Q_m values 1.5 higher). Additionally, different regeneration processes were evaluated to prolong the lifetime of sorbent reusability.

References:

[1] J.O. Ojoghoro, M.D. Scrimshaw, J.P. Sumpter, Science of The Total Environment 2021, 792, 148306.
[2] Q. Yu, J. Geng, Chemosphere 2019, 237, 124371.
[3] https://environment.ec.europa.eu/publications/proposal-revised-urban-wastewater-treatment-directive_en.