

Tuna bone char as a waste-derived sorbent for the removal of contaminants of emerging concern from saline wastewater

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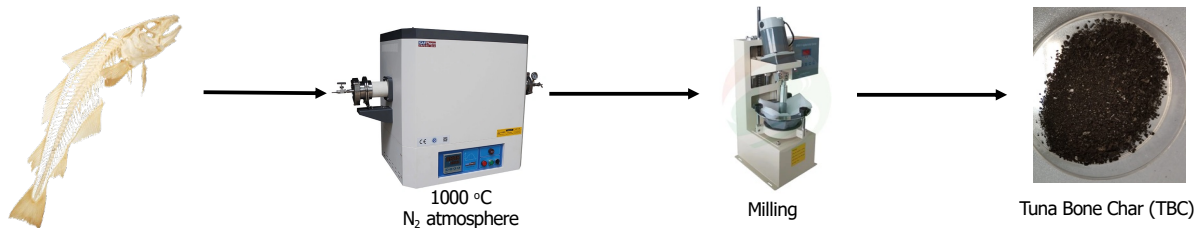
Introduction

Today one of the main problems affecting our environment is the presence of Contaminants of Emerging Concern (CECs) in surface waters. CECs are stable compounds that are not degraded by traditional wastewater treatments processes, accumulating in the environment and potentially causing harm. Within CECs, pharmaceuticals are of particular concern, due to their increased consumption, with the new EU legislation aiming at the improvement of the quality of the treated wastewater to be discharged, especially in what these pollutants.

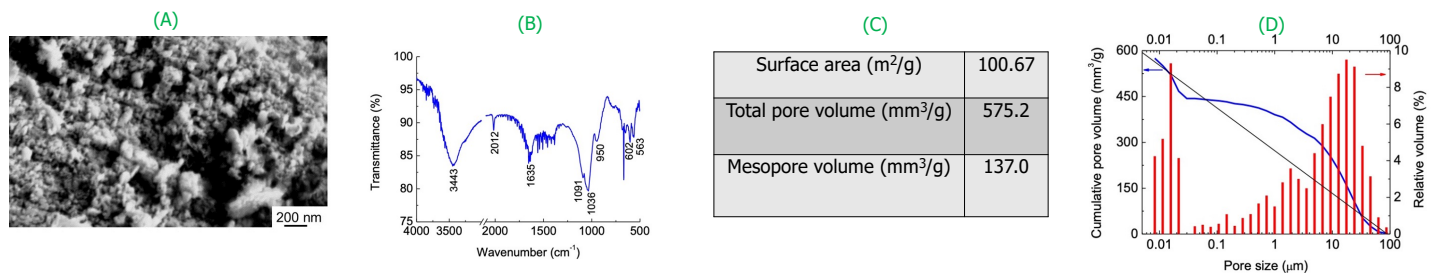
In the present work, a material derived from tuna fish bones was prepared by a pyrolysis process (Tuna Bone Char, TBC) and then used to adsorb two pharmaceuticals, tramadol (TRA) and venlafaxine (VNF). The adsorption assays were performed in aqueous matrices simulating wastewaters with different levels of salinity.

Tuna Bone Char (TBC) preparation and characterisation

Tuna bones were pyrolyzed in N₂ atmosphere at 1000 °C; the material was mechanically grinded to obtain a uniform powder.



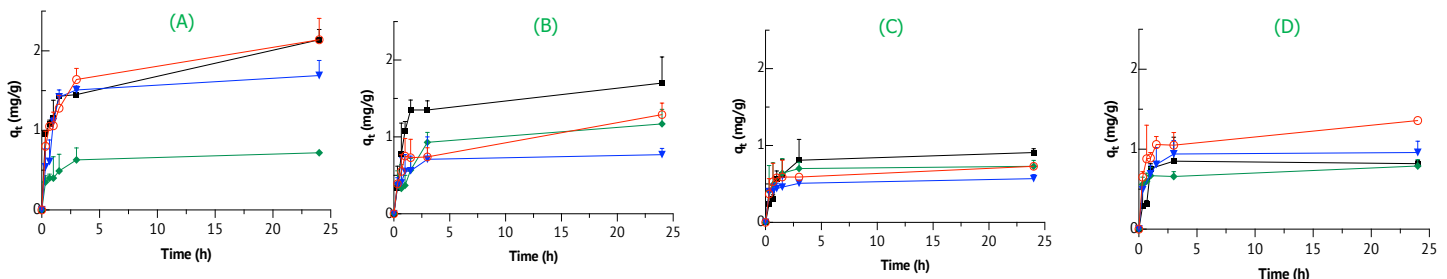
Scanning Electron Microscopy (SEM) (A) performed on the powder showed that TBC has a nanometric structure; indeed, rounded particles of about 40 nm diameter were detected. FTIR analysis (B) showed the presence of peaks characteristic of calcium phosphates (1091 and 1036 cm⁻¹) and OH groups (3443 cm⁻¹) confirming the presence of hydroxyapatite Ca₁₀(PO₄)₆(OH)₂, the main bone component. Peaks associated with carbon derivatives were also present (2012 and 1635 cm⁻¹).



BET surface area measurements (C) showed that TBC has a high surface area and total pore volume. The analysis of the pores dimensions (D), on the other hand, showed a bi-modal distribution with dimensions at both nanometric and micrometric scales.

Adsorption experiments

Batch experiments were performed to assess the effect of the matrix's chemical composition on the efficiency of the adsorption process using different aqueous matrices: deionized water (■), non-saline wastewater (○), saline wastewater w/ 7.5 g/L salts (▼) and saline wastewater w/ 12 g/L (◆). Moreover, TRA and VFN, used as target model pollutants, were tested alone (A and B respectively) and in mixture (C and D respectively).



TRA had a higher affinity to TBC than VFN, as the q_t values were generally higher. In mixture, however, no preferential pollutant adsorption was observed.

The water matrix had a significant effect on the adsorption effectiveness, as generally higher complexity and salinity level led to lower adsorption capacity. This effect was more pronounced when pharmaceuticals were supplied alone in the matrix than in a mixture.

Conclusions

- Tuna bones were successfully converted into a powder material with a high surface area, suitable for environmental remediation/pollutants adsorption.
- Pharmaceutical compounds classified as CECs were removed from different water matrices using the TBC powder.
- The chemical nature of the pharmaceutical possibly affected the adsorption process.
- The salinity level of the wastewater also affected significantly the adsorption capacity of the TBC.

Acknowledgments

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