Low-cost adsorption treatment using biochar: Influencing factors and reusability

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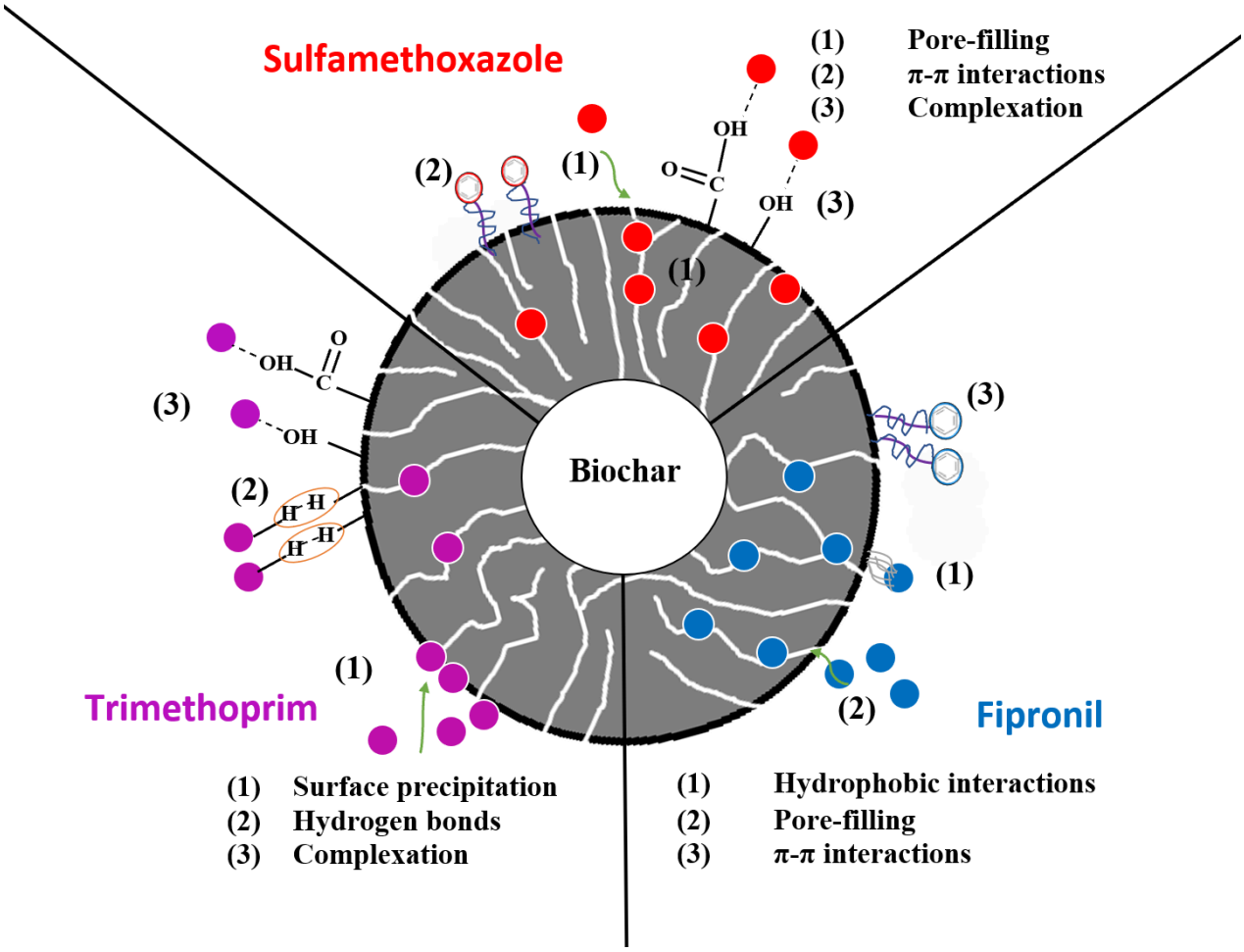
ABSTRACT

As climate change affects the distribution of rainfall and raises temperatures across the region of the Euro-Mediterranean, the demand for effective water management solutions rises (Spano et al., 2020). With the continued expansion of industry and agriculture, the concentration of organic contaminants in water has increased in recent years, resulting in significant contamination and shortage of water (Baaloudj et al., 2021). Organic compounds are one of the most notable categories of developing pollutants. Some of them are biologically active and have a variety of harmful effects on human health and the environment (Brahimi et al., 2022). True, polluted water is hazardous to the environment, however, this resource, which is sometimes ignored, has enormous potential for both quantitative and qualitative reuse, minimizing environmental consequences and encouraging water sustainability (Grenni et al., 2018). Several approaches are now being tested to remove organic compounds from water, including biological (Li et al., 2018), electrochemical treatments (Chianese et al., 2023), membrane separation technologies (Espíndola et al., 2019), and adsorption (Bizi, 2020). A treatment method must be efficient and financially viable to be marketed and implemented on a large scale, meeting both economic and environmental requirements (Silva, 2023). Adsorption appears to be the most effective treatment option due to its ease of use and low cost (Guo et al., 2020). Intensive research efforts are presently being undertaken to create effective and low-cost adsorbents for eliminating organic pollutants (Al-Buriahi et al., 2022; Ding et al., 2023; Huang et al., 2020). Although there has been much research on adsorbents for the removal of organic compounds from water in the past several years, biochar has received significant scientific attention due to its suitable specific surface area, adjustable surface chemistry, expandable manufacturing, and material availability, simple preparation methods, improved physicochemical properties and being an environmentally friendly and low-cost material, which is generally produced from organic waste (Ahmed et al., 2015; Huang et al., 2022; Powlson et al., 2011; Tomczyk et al., 2020). Forest residues from reconstruction activities and harvesting timber can cause a variety of problems including forest fires, which contribute to climate change, therefore eliminating them and producing biochar can give significant advantages to ecosystems (Han et al., 2018). In this context, this research investigates the adsorption efficiency of biochar derived from forest residues in Northwestern France for the elimination of newly discovered pollutants from water, including Fipronil (FPN), Trimethoprim (TRM), and Sulfamethoxazole (SMX). These pollutants were chosen for inclusion in this work's adsorption applications because of their extensive presence in water, potential harm to human health and ecology, and recognition as emerging contaminants of concern as mentioned in the watch list of Commission implementing decision (EU) 2022/1307, of 22 July 2022 (European Commission, 2022). The tested biochar has shown an effective removal for these pollutants with an efficiency of 77% and 89% for FPN and TRM respectively after 30 min and 96% for SMX after 1 hour. Pollutant chemisorption on biochar surfaces has been characterized using isotherms and kinetic models. After that, the effect of operating parameters such as pH, initial SMX concentration, and adsorbent dose has been tested in batch mode on one of these pollutants in order to optimize the process A regeneration study just using water has also been done and it revealed a reusability of around 88% in the first cycle which is acceptable and can be improved. This communication aims to improve the quality of reclaimed wastewater for safe and

sustainable reuse by using biochar as an adsorbent to eliminate the hazardous organic material in water, in order to promote circular resource management practices and address environmental issues.

Keywords: Organic contaminants, Adsorption, Biochar, Forest residues, Regeneration, Wastewater reuse.

GRAPHICAL ABSTRACT:



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