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DETERMINATION OF PHARMACEUTICAL SUBSTANCES IN WASTEWATER OF THE PHARMACEUTICAL INDUSTRY AND THEIR PURIFICATION USING ION EXCHANGERS

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Antibiotics are not biodegradable, can persist in aquatic environments for long periods, and have a high potential for bioaccumulation in the environment. They undergo extensive metabolism in humans, animals, and plants. After metabolism, antibiotics or their metabolites are released into the aquatic environment. These compounds can be removed from water through various processes. However, antibiotics are not effectively treated in conventional wastewater treatment plants [1]. Antibiotics are widely used worldwide in medicine to treat infections. Their occurrence and fate in the environment attract particular interest, especially due to the spread and persistence of antibacterial resistance. In Switzerland, the annual consumption of two major groups of antimicrobial agents—sulfonamides and macrolides—is approximately 6 and 4 tons per year, respectively. After consumption, pharmaceuticals used by humans enter municipal wastewater treatment systems either unchanged or as human metabolites and may eventually reach surface waters [2, 3]. Their behavior during wastewater treatment, as well as the efficiency of different treatment stages and technologies, remains largely unknown. Sulfonamides (SA) are an important class of synthetic antimicrobial drugs with a broad pharmacological spectrum used to treat bacterial infections in humans and animals. SA derivatives are organosulfur compounds

containing -SO_2NH_2 or -SO_2NH- groups and are characterized by the presence of a sulfonamide group and specific 5- or 6-membered heterocyclic rings. SAs are not easily biodegradable and may cause various adverse side effects, such as digestive and respiratory system disorders [4]. The concentration of antibiotics in aquatic environments depends on the source of wastewater (domestic or industrial) and typically ranges from 0.4 ng/L to 64 µg/L. Due to the global COVID-19 pandemic, the use of antibiotics to control infections has increased significantly. As a result, antibiotic concentrations in both wastewater and surface waters have risen rapidly. Adsorption is considered one of the most effective, inexpensive, fast, easily scalable, operationally efficient, and relatively environmentally friendly technologies for removing antibiotics from water and wastewater. Carbon-based materials such as biochar, hydrochar, graphene, carbon nanotubes, and activated carbon are commonly used as effective adsorbents for removing various environmental pollutants, including antibiotics from aqueous media. These carbon materials exhibit high adsorption capacity due to their excellent physicochemical properties, such as high porosity, large specific surface area, numerous surface functional groups, and high heterogeneous reactivity. Among various carbon-based materials, biochar and hydrochar receive more attention because they are relatively inexpensive, being produced from various biological wastes (e.g., wood waste, agricultural residues, etc.). Considering the increasing use of antibiotics and recent advances in the preparation of biochar/hydrochar to achieve high adsorption efficiency, it is necessary to critically analyze the existing knowledge base in the literature regarding antibiotic removal using these materials. Most studies on the effects of antibiotics on plants have mainly focused on evaluating phytotoxicity. However, concerns are growing that antibiotics can be absorbed by food crops and enter food supply systems [5]. Unlike animals, plants do not excrete these substances; therefore, antibiotic residues can accumulate in plant tissues. Once antibiotics enter the food chain through uptake by crops from soil,

they may pose potential risks to human health. Therefore, research on the uptake of antibiotics by plants from soil is highly important and relevant.Based on the above, the aim of our study is to remove azithromycin from pharmaceutical industry wastewater using ion-exchange materials.

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