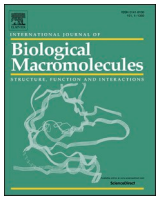
International Journal of Biological Macromolecules 296 (2025) 139787



Contents lists available at ScienceDirect

International Journal of Biological Macromolecules

journal homepage: www.elsevier.com/locate/ijbiomac





Adsorption of sulfamethoxazole in an aqueous environment onto a novel magnetic sporopollenin–cellulose triacetate

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ARTICLE INFO

Keywords:
Cellulose triacetate
Magnetic nanoparticles
Pollutant
Sporopollenin
Sulfamethoxazole

ABSTRACT

Antibiotics are emerging environmental contaminants posing critical health risks due to their tendency to concentrate in living things and eventually infiltrate the human body. Sulfamethoxazole (SMZ) is among the commonly detected antibiotics in wastewater requiring effective removal approach. A sustainable, thermally stable and easily separable magnetic sporopollenin-cellulose triacetate (Msp-CTA) was developed via a simple step synthesis for eliminating SMZ from aqueous solution. The assessment of Msp-CTA characteristics via instrumentations revealed a mesoporous adsorbent having COO-, -OH, C═O, and Fe − O as its potential adsorption binding sites. Improved stability gained from blending sporopollenin (Sp) and cellulose triacetate (CTA) was affirmed through TGA analysis. Minimal competition for the adsorption sites by H^+ and OH^- favours efficient SMZ adsorption onto Msp-CTA at pH 3 and 5 with %removal of 78.7 and 83.1 %, respectively, using 40 mg/L initial SMZ concentration. The monolayer adsorption capacities 15.14 and 15.52 mg/g were obtained from nonlinear and linear Langmuir isotherms, respectively. The adsorption process is best described by Temkin > Hill > Langmuir > Freundlich isotherms based on proximity of correlation coefficient R^2 to 1. The best fit to Temkin suggests that SMZ adsorption's energy decreases proportionally with increasing surface coverage of Msp-CTA. The adsorption process is arbitrated to conform best to pseudo-second order (PSO) kinetic, though a bias is perceived in the linear fitting. Msp-CTA shows reusable potential with 65.9 % desorption at third cycle. The thermodynamic studies revealed an endothermic process. Hence, Msp-CTA demonstrates potential as an alternative adsorbent for sulfonamide-based antibiotics' removal from wastewater.

1. Introduction

In recent years, there has been an increasing interest in pharmaceuticals' ubiquity and its potential effects on the environment [1]. Antibiotics are among the most consumed and widely used pharmaceuticals [2]. Aside from being possible contaminants in wastewaters from the pharmaceutical industry, the extensive use of antibiotics in agriculture and medicine among other fields, have made it detectable across wastewater channels due to it persistence in the environment [1,3]. Various water systems and channels, including surface water, urban groundwater, and municipal sewer systems, have all been found to contain varying amounts of antibiotics and antibiotic resistance genes (ARG) [3–5]. Because of existence of antibiotics and their resistance genes in the environment, these substances have posed a direct threat to living things and indirectly to human health, as their existence in the environment has been linked to the spread of drug resistance [6–9].

Sulfonamide antibiotics are the first antimicrobial drugs among the common antibiotics used to treat bacterial and some fungal infections, and have been detected in the aquatic ecosystem, thereby weakening their antibacterial qualities, and facilitating the spread drug resistance in bacteria [6,10]. A prominent member of the sulfonamide antibiotic class is sulfamethoxazole (SMZ), a stable molecule with two aromatic rings (see Table 1) [11–13], used for both human and veterinary treatment due to its relatively low cost [14].

Based on the US Geological Survey, SMZ is ranked among the top 30 most commonly detected pollutants in wastewater with a half-life of at

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https://doi.org/10.1016/j.ijbiomac.2025.139787
Received 31 October 2024; Received in revised form 6 January 2025; Accepted 10 January 2025
Available online 12 January 2025
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