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Preparation, characterization and adsorption potential of the NH_4Cl-induced activated carbon for the removal of amoxicillin antibiotic from water

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HIGHLIGHTS

- NH_4Cl-induced activated carbon (NAC) was prepared from a waste biomass.
- The prepared NAC was a mesoporous material with a BET surface area of 1029 m^2/g.
- NAC had a high density of hydroxyl, carbonyl, carboxylic, and carboxylate surface functional groups.
- NAC had an amoxicillin adsorption rate of up to 4.3 times greater than the standard AC.
- NAC had an amoxicillin adsorption capacity of 2 times of that of the standard AC.

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ABSTRACT

The preparation, characterization and application of NH_4Cl-induced activated carbon (NAC) for amoxicillin removal from the contaminated water were studied. The prepared NAC had a specific surface area of 1029 m^2/g and a mean pore volume of 2.46 nm. Over 99% of 50 mg/L amoxicillin (AMX) was adsorbed using 0.4 g NAC/L at the optimum solution pH of 6; while standard activated carbon (SAC) could only adsorb around 55% of AMX under similar experimental conditions. Kinetic analysis revealed that adsorption experimental data for both NAC and NAC were best fitted by the pseudo-second-order model, with the greater rate for NAC than for SAC. Results of equilibrium experiments indicated that adsorption of AMX onto SAC and NAC were better described by the Langmuir model. The maximum adsorption capacity of AMX onto SAC and NAC was 262 and 437 mg/g, respectively. AMX adsorption onto SAC increased from 76.8% to 92% with increased temperature from 10 to 35 °C. However, a further increase of temperature to 50 °C led to declining AMX removal to 78.1%. Overall, these results indicate that developed NAC was an efficient adsorbent that presents an attractive adsorbent method for application in treating contaminants in water.

1. Introduction

Pharmaceuticals present class of health care products that are intensively used worldwide to promote human health and well being as well applications in animal care and agriculture. Among pharmaceuticals, antibiotics are the most widely used drug for the prevention or treatment of bacterial infections in humans, animals and plants [1]. Antibiotics are released into bodies of water mainly through effluent of municipal wastewater treatment plants, as well as through effluent from pharmaceutical manufacturing plants. Pharmaceuticals are gaining recognition as being environmental contaminants, classified as recalcitrant bio-accumulative compounds and are thus regarded as hazardous chemicals. The release of pharmaceuticals into the environment thus results in contamination of aquatic or terrestrial ecosystems [2]. Effluent containing antibiotics needs to be treated chemically or physically to prevent the adverse effects from contaminated water. Although chemical processes, especially advanced oxidation processes, can often degrade and decompose antibiotics' molecules into simple compounds and/or mineralize them, these processes are very expensive and difficult to operate for complete elimination of recalcitrant compounds including antibiotics. Physical techniques remain the most appropriate treatment option and adsorption is among the most efficient of these techniques for removing organic compounds from industrial effluent [2,3]. Adsorption is efficient, simple to design and operate and it is unaffected by toxicity as well as being inexpensive [4]. Adsorption therefore presents an efficient

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