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STUDY OF CIPROFLOXACIN ADSORPTION ISOTHERSONSPENT COFFEE GROUNDS

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ABSTRACT

The adsorption isotherms of ciprofloxacin (CIP) by the spent coffee grounds (SCGs) was investigated. The adsorption isotherms were well described by the Langmuir model. This suggested that the strong interaction of CIP with the SCGs. Therefore, SCGs, as a green, environmental-friendly adsorbent, can be applied to the adsorption of contaminants in environment.

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INTRODUCTION

Fluoroquinolones, which act as inhibitors of DNA topoisomerase II, exhibit both strong bactericidal and sterilizing activities; as one of the quinolones, ciprofloxacin (CIP)is one of the drugs which was widely used(Zhang*et al.,* 2019).However, CIP is considered highly harmful to plants, algae, and bacteria, as well as hazardous to animals and human. Therefore, the monitoring of CIPin various environmental samples became crucial.In recent years, biomass is used as sorbents to adsorb drugs due to their big surface area, low-cost usage, feasible generationand excellent adsorption properties. Spent coffee grounds (SCGs), as one of the biomass residues, can be used as an inexpensive adsorbent for removal of pollutants (Anastopoulos*et al.,* 2017).In thisstudy, SCGs was applied to adsorb CIP. The adsorptive kinetics and adsorptive isotherm of SCGs for CIP were investigated. The results were analyzed by high performance liquid chromatography (HPLC).

EXPERIMENTAL

Chemicals and Materials: CIP was purchased from Sigma-Aldrich (Steinheim, Germany), high performance liquid chromatography-grade methanol (MeOH) and acetonitrile (ACN) were provided by J&K Chemical (Beijing, China). NaH_2PO_4, H_3PO_4, NaOH, and other affiliated chemicals were all obtained from Sinopharm Chemical Reagent Co. Ltd. (Shanghai, China). All solvents and chemicals were of analytical grade and used without further purification unless otherwise specified.HPLC-grade water was obtained by purifying demineralized water in a Milli-Q system (Millipore, Bedford, MA, USA), and was used throughout the work.

Apparatus and software: For chromatographic separation, an Agilent 1260 HPLC system (Agilent Technologies, CA, USA), equipped with a quaternary pump, a degasser, a column compartment, and a UV detector were used. Separation was performed on a Pursuit 5 C18, 5 µm, 4.6 mm ×150 mm column. The injection volume was 20 µL and the ultraviolet (UV) detector was set at 278 nm. The mobile phase consisted of 0.2% acetic acid and ACN with a ratio of 85:15 (v:v) at a flow rate of 1.0 mL/min. All the samples were passed through microporous nylon filters of 0.22µm pore sizes in diameter (Pall Corporation, USA). An Ion 510 pH meter (Ayer Rajah Crescent, Singapore) was used to monitor pH adjustment. A centrifuge (Xiangyi, Hunan, China) was used for sample preparation.

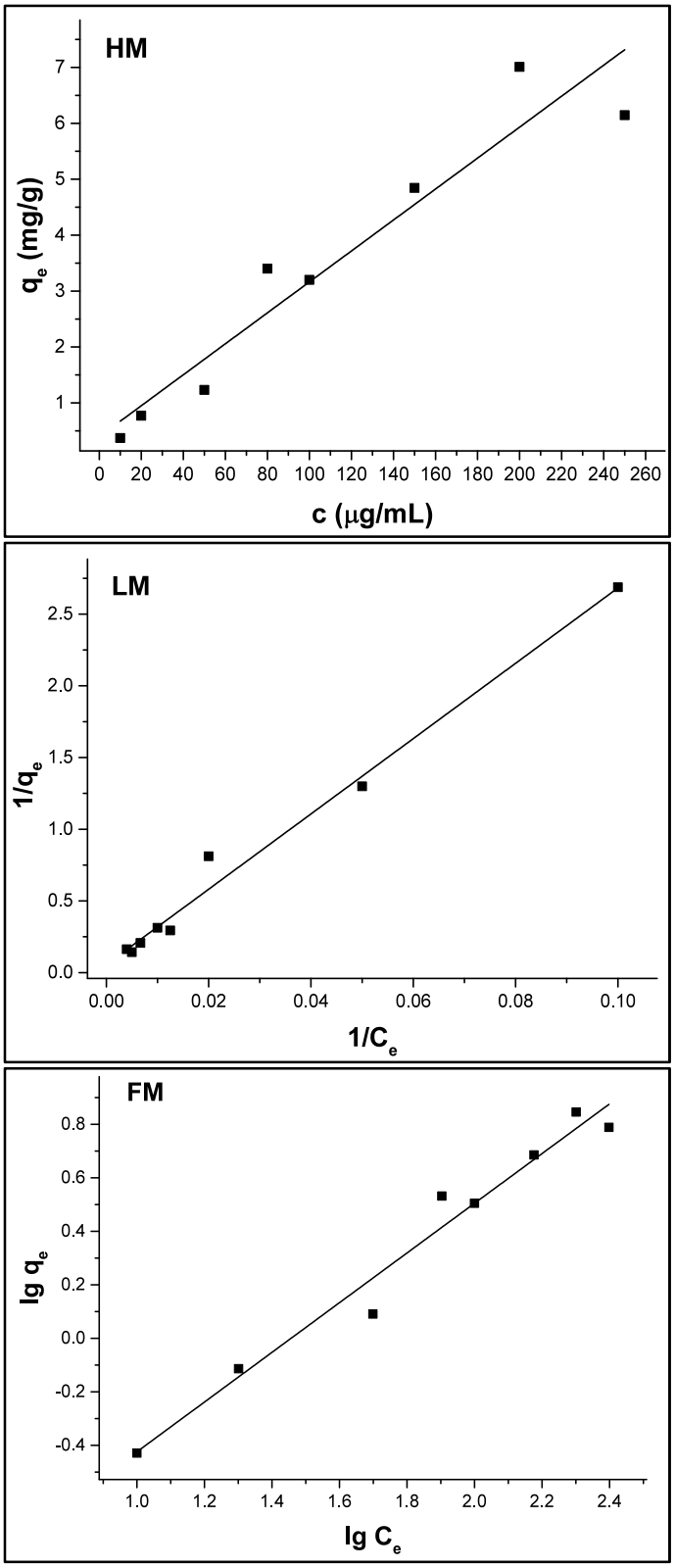

Figure 1. Fitted curve of HM, LM and FM

Preparation of standard: Standard stock solution containing 1000μg/mL of CIPwas prepared by dissolving the required amounts of the standard in MeOH. It was stored in a refrigerator at 4 °C. Working solutions were prepared from the stock solutions by dilution with appropriate amounts of Milli-Q water.

Adsorptive performance experiment and isotherm modeling: Each desired CIP concentration used in batch experiments was prepared by appropriately diluting the stock solutions with 10 mmol/L NaH_2PO_4 and successive dilutions. SCGs were added into 5 mL CIP solution with a fixed concentration. All the adsorption experiments were performed in conical flasks under ultrasonic bath for 0.5 h to achieve an adsorption equilibrium. After adsorption, all solutions were filtered through 0.22μm membrane filters and analyzed by HPLC. The adsorption capacity (q_e, mg/g) of SCGs for CIP, three common isotherm models, such as Henry model (HM), Freundlich model (FM) and Langmuir model (LM) werereferenced by our previous work (Wang *et al.,* 2021).

RESULTS AND DISCUSSION

Adsorption isotherms: The adsorption isotherm is crucial in understanding the adsorption capacity of SCGs and very useful to describe how the CIP distribute on the SCGs when the adsorption process reaches an equilibrium state. In order to study the mechanism of the adsorption, equilibrium adsorption data of the CIP were described using well-known HM, FM and LM. The correlation coefficients (R^2) obtained in fitting adsorption data in three models, the adsorption parameters (K_D, K_F, K_L and 1/n) for the three MOX onto the SCGs are referred in Table 1.Moreover, the fitted curve of the three models were shown in Figure 1.The results shown in Figure 1and Table 1 indicated that the curve of CIP fitted well to the LM. A non-linear LM can be used to describe homogeneous adsorption systems in which adsorption takes place on a homogeneous surface by a monolayer without any interaction between the adsorbed molecules. (Sheshmani*et al.*,2014). At the initial stage of adsorption, numbers of vacant sites were supplied for MOX, therefore, the curve increased sharply; however, adsorption weakened when the vacant sites were less.

CONCLUSIONS

In conclusion, a green, environmental-friendly adsorbent was supplied to the CIP adsorption. The adsorption isotherm indicated that the LM fitted better than HM and FM. As a highly efficient adsorbent for CIP, SCGs could be a candidate to adsorb contaminants in environment in the future.

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