CAPECITABINE REMOVAL FROM WATER USING COMMERCIAL GRANULAR ACTIVATED CARBON

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Abstract

The aim of this study consisted of removal of capecitabine (CCB), a cytostatic that is often used in cancer therapy and its presence in water exhibited negative impact and risk on the human health. Granular activated carbon (GAC) was tested as sorbent in batch system for CCB removal from water, considering its common usage in water/wastewater treatment technology. Influence of operation variables, *e.g*, pH, GAC dose and CCB initial concentrations, was studied to optimize GAC-based sorption for CCB removal.

Introduction

It is known that a large number of pharmaceutical agents are consumed annually wordwide and this has become an increasing source of water pollution [1]. Thus, a main cause of anticancer drugs in the aquatic environment is given by hospital effluents due to forms of pollution, such as the excretion of patients under the chemotherapy procedure [2]. Capecitabine (CCB) has become one of the most well-known anticancer drugs that led to the expansion of the drug list being known as a new compound at patients with different types of cancer[3], and as consequence, its presence in water has been reported.

Granular activated carbon (GAC) – based filtering belongs the mature technology for the water/waste water treatment but its performance for removal emerging pollutants and especial, cytostatics, has not been studied.

In this study, GAC ability to remove CCB from water by adsorption is investigated considering the effect of pH, GAC dose and CCB concentration range.

Experimental

All batch sorption experiments were carried out under stirring conditions (Figure 1). The influence of different parameters were studied in static system, *i.e.*, pH of 3, 5, 7 and 9, GAC dosage of 1, 5, 10 and 20 gL^{-1} and CPB concentrations of 1, 2.5, 5, 10 and 20 $mg{\cdot}L^{-1}$.

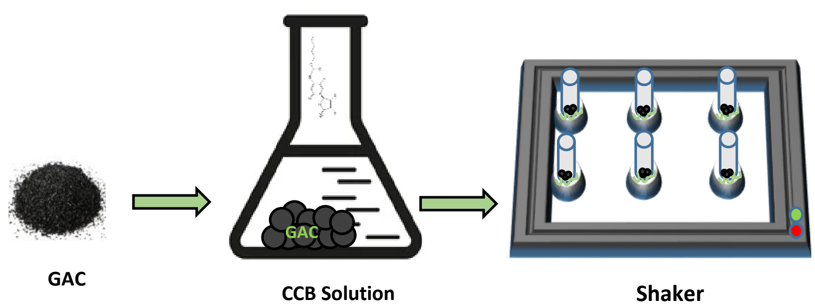

Figure 1. *Schematic representation of batch adsorption*

CCB concentration was assessed in terms of absorbance recorded at A_{240} nm chosen based on UV-Vis spectrum of CCB, presented in Figure 2. Taking into account, the sorption is a separations process that led to same evolution of all UV-Vis peakes, A_{240} was selected to simplity the discussions.

Also, GAC performance was evaluated considering CCB removal degree (η), determined based on equation (1):

$$\eta = \frac{\boldsymbol{A}240,i - \boldsymbol{A}240,f}{\boldsymbol{A}240,i} \cdot \mathbf{100} \quad (1)$$

where:

A_{240}, i -is the absorbance recorded at the wavelength of 240 nm for initial capecitabine concentration,

A_{240}, f -is the final absorbance recorded at the wavelength of 240 nm for final capecitabine concentration.

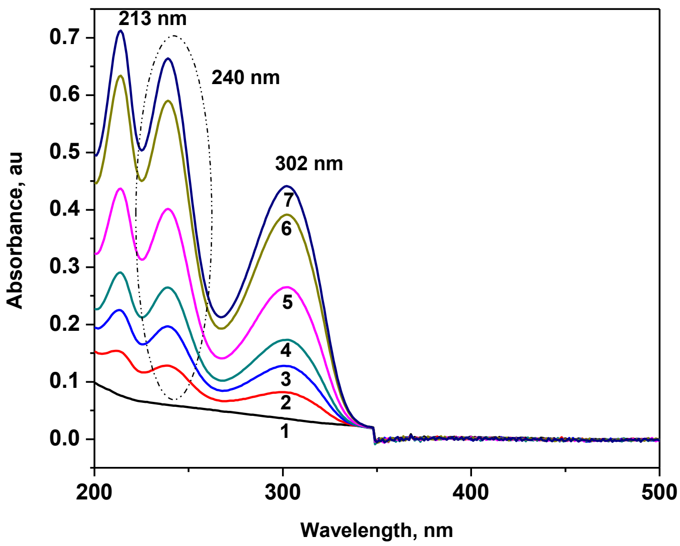

Figure 2. *UV-Vis spectrum of CCB (**1**- based line; **2**-2.5 mg·L^{-1}; **3**-5 mg·L^{-1}; **4**-7.5 mg·L^{-1}; **5**-10 mg·L^{-1}; **6**-12.5 mg·L^{-1}; **7**-15 mg·L^{-1})*

Results and discussion

pH is one of most important variable considered for sorption. Also, CCB is a weak acid that is ionized at pH>7 [4]. Figure 3 presents the results related CCB removal at pH of 3, 5, 7 and 9.

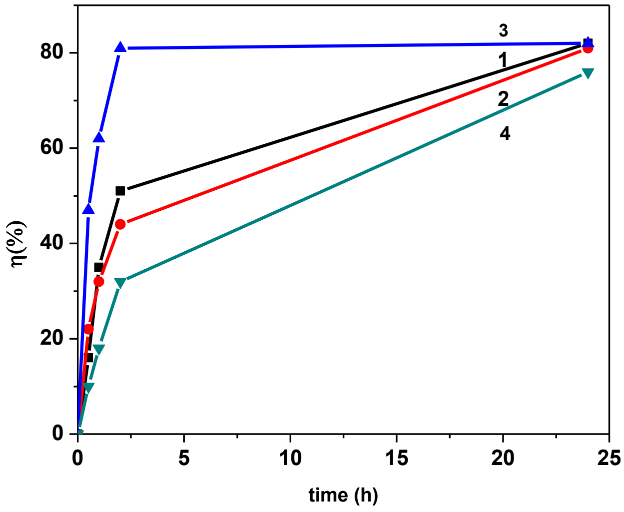

Figure 3. *Time- evolution of CCB removal degree at different pH (**1**-pH3; **2**-pH5; **3**-pH7; **4**-pH9)*

It can be noticed that the worst removal efficiency was achieved at pH=9 and the best one at the neutral pH of 7, for the dose of 5 g·L^{-1}. After 24 h of sorption, the removal efficiency was similarly for all tested pH, which shows that acidic pH necessitates a longer contact time to achieve the equilibrium. Based on above presented results, pH of 7 is recommended as optimum one.

Various GAC doses were tested for neutral of 5 mg·L^{-1} CCB at pH=7 and the results are presented in Figure 4.

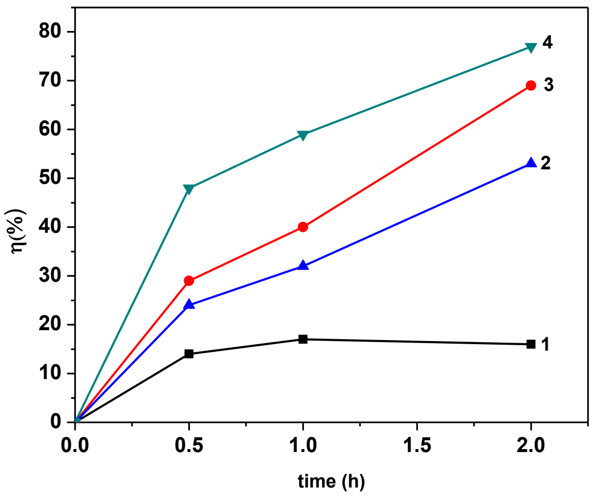

Figure 4. *Time- evolution of CCB removal degree at different GAC doses (**1**- 1 g·L^{-1}; **2**-5 g·L^{-1}; **3**-10 g·L^{-1}; **4**-20 g·L^{-1})*

Increasing GAC dose the CCB removal degree increated, manifested especialy for short time of soprtion. 5 g·L^{-1} CA at pH=7 is tested for removal of CCB with concentrations ranged from 1 mg·L^{-1} to 20 mg·L^{-1}.

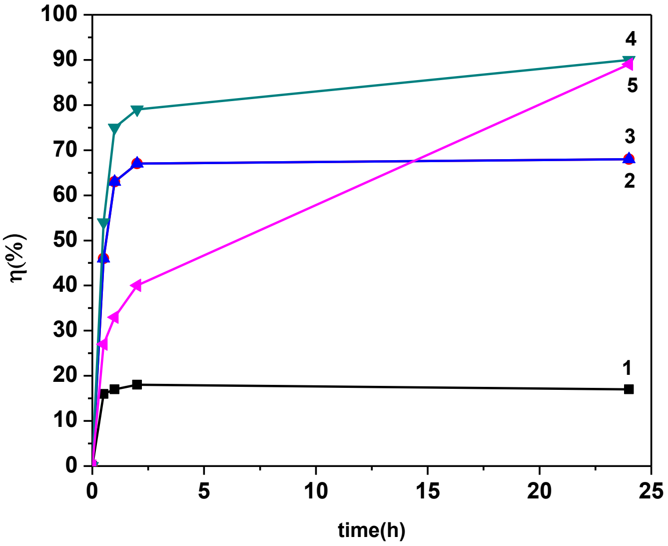

Figure 5. *Time- evolution of CCB removal degree at different initial CCB concentrations (**1**- 1 mg·L^{-1}; **2**- 2.5 mg·L^{-1}; **3**- 5 mg·L^{-1}; **4**-10 mg·L^{-1}; **5**- 20 mg·L^{-1})*

The lowest CCB removal was achieved for the lowest CCB concentration (1 mg·L^{-1}) due to no driving force for sorption process is assured. CCB removal degree increased with initial CCB concentration until 10 mg·L^{-1}, while CCB concentation of 20 mg·L^{-1} was too high considering GAC dose of 5 g·L^{-1}.

For initial CCB concentration ranged from 1 to 10 mg·L^{-1}, the equilibrium was reached after 2 h contact time, while at higher CCB initial concentrations (20 mg·L^{-1}) it is requered 24 h contact time.

Conclusion

This study demonstrated the potential of GAC to remove CCB from water, which support the application of conventional GAC filtering advanced treatment of CCB containing water/wastewater.

Acknowledgements

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