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ZEOLITE: AN ALTERNATIVE SOLUTION FOR ANTIBIOTIC REMOVAL FROM WASTEWATER

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Antibiotic pollution has become a global emergency because these chemical compounds are one of the main causes of inducing bacterial resistance to antibiotics, rendering them ineffective for human treatment. Consequently, antibiotics have been frequently detected in surface water, groundwater, soil, sediments and sewage treatment plants, indicating their resistance to biodegradation and persistence in natural environments, where they may cause critical environmental problems. Antibiotic removal could be achieved by adsorption (e.g with zeolites) or bacterial biodegradation. This study focused on the removal of the fluoroquinolone antibiotic norfloxacin from aqueous solutions using synthetic zeolite. Although the SFIO/34 of norfloxacin on synthetic zeolite as a cost-effective adsorbent has not yet been addressed, the adsorption method can be considered an effective method for the removal of fluoroquinolones from various contaminated media. There is a need for cheap and efficient adsorbents for the removal of antibiotics from wastewater. The maximum adsorption capacity of antibiotics by synthetic zeolite (ZSM-5) following the Langmuir isotherm model was 2.4307 mg/l.

Materials and methods

The study investigated the effect of antibiotic standard (from Sigma Aldrich in powder form) - zeolite (synthetic ZSM-5, zeolite Socony Mobil-5) adsorption on bacterial growth by disc diffusimetric method with the tested Gram-negative reference strain, *Escherichia Coli* - ATCC 25922. A pure bacterial culture of *Escherichia Coli* was distributed in a Petri dish with medium by cloth seeding technique. Qualitative sensitivity screening was performed by a Mueller-Hinton solid medium diffusion fit method. The batch adsorption study was performed by adding 0.2 g zeolite to a solution of 0.5 µg/L and 2 µg/L norfloxacin for 5 minutes at room temperature (approximately 22°C) in a series of 250 mL conical flasks. Diffusimetric discs were soaked in the supernatant from the zeolite-antibiotic adsorption tests. The soaked discs were applied to the Petri dish at a distance of approximately 2 cm from the edge of the Petri dish and at a distance of 3 cm from each disc, then incubated at 35°C for 22 hours.

Results and conclusions

The ability of zeolites to remove pollutants is based on excellent adsorbent properties and ion exchange capacity. In addition, the special pore architecture makes them suitable candidates for hosting and further delivering, under appropriate conditions, a variety of molecules of pharmaceutical interest. The ability of zeolite to remove antibiotics was tested by the disk diffusion method. In the first step, bacterial inhibition was shown to be directly related to antibiotic concentration 2 pg/L to 0.5 pg/L (data not shown). In general, the zeolite adsorbed certain amounts of the antibiotic (norfloxacin), improving the degree of removal of the antibiotic from the waste. In our tests, we showed for the first time that by adding zeolite to a certain concentration of antibiotic solutions (2 µg/L - Fig.1A or 0.5 µg/L norfloxacin - Fig. 1B), the inhibitory effect of antibiotics on bacterial strains decreased. The results showed that the addition of zeolite to antibiotic solutions decreased the inhibitory effect on bacterial strains of 2 µg/L antibiotics by 56% (Fig.1A) and for 0.5 µg/L antibiotics by 75% (Fig.1A). The removal of the antibiotic by zeolite decreased the antibiotic concentration and subsequently decreased the inhibition of bacterial growth.

A B

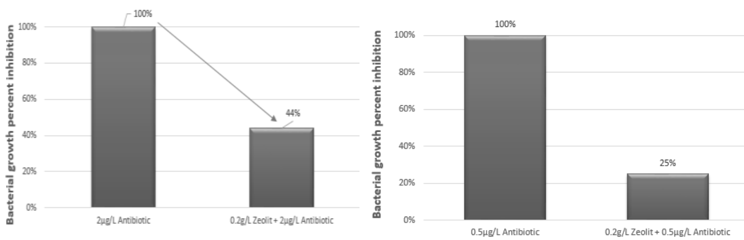

Fig. 1. Zeolite modulates the effect of (A) 2µg/L or (B) 0.5µg/L antibiotic on bacterial strains.

In conclusion, Zeolite, in addition of being a very good detoxifier, due to its molecular structure, it could capture the antibiotics, being an excellent alternative for antibiotic removal during the wastewater treatment. This could prevent fuelling the emergence and spread of antibiotic resistant bacteria, which according to WHO the antibiotic resistance phenomena is the third major issue to be solved by the human society. Adsorption and biodegradation are the two major pathways of antibiotic removal. Adsorption is the main mechanism of antibiotics, and the process of microbial metabolism contributes to the biodegradation of antibiotics. These combined methods should be investigated as prospects for application in antibiotic disposal in the future.

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