# A NOVEL ZEOLITE-BASED ADSORBENT FOR CIPROFLOXACIN REMOVAL FROM WATER MEDIA

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## 1. BACKGROUND

In the last decades, the use of antibiotics has constantly increased in both human and veterinary medicine. Since water pollution by these contaminants is poorly regulated, different types of antibiotics can be found in both surface and drinking water.

Antibiotics possesses:

- **complex structure,**
- **high stability,**
- **long-lived persistence in the environment,**
- **toxic effects towards organisms.**

**Bacterial resistance** → **Risk to human health!**

### Ciprofloxacin (CIP)

- zwitterion

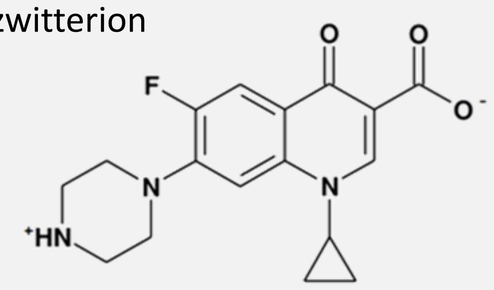
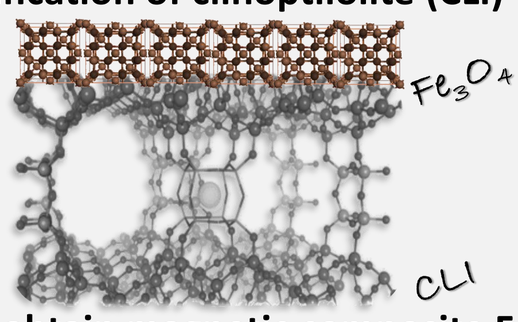


***Fig. 1*** *CIP structure in a zwitterionic form.*

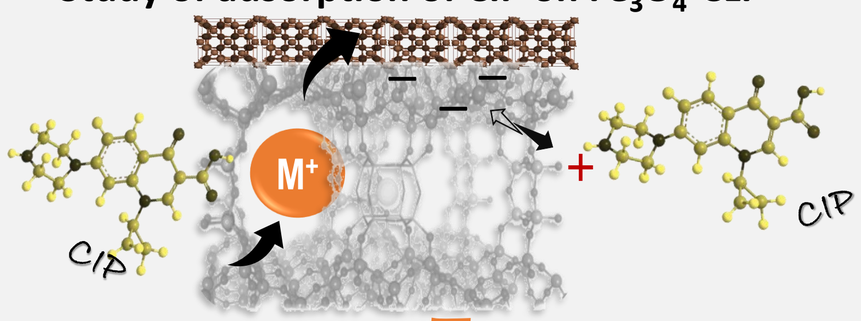
## AIMS

**Modification of clinoptilolite (CLI)**

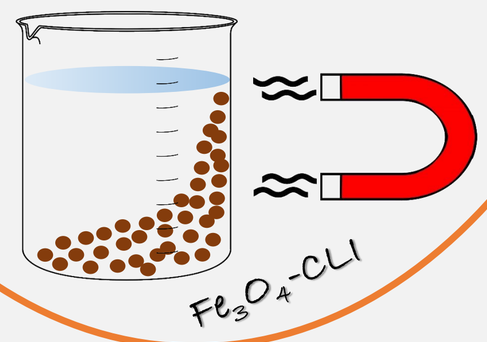



**with $Fe_3O_4$ to obtain magnetic composite $Fe_3O_4$-CLI**

**Study of adsorption of CIP on $Fe_3O_4$-CLI**




**Easy separation from suspension**




## 2. COMPOSITE CHARACTERIZATION

- Modification of CLI to $Fe_3O_4$-CLI did not significantly affect the CLI crystallinity.
- Diffractions at 2θ = 35.64˚, 43.23 ˚ and 62.96 ˚ suggest the presence of $Fe_3O_4$.

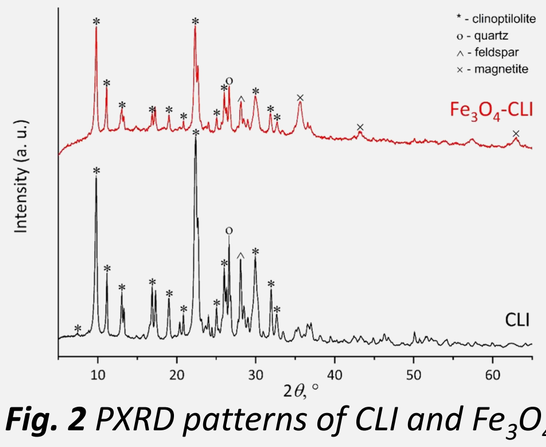



***Fig. 2*** *PXRD patterns of CLI and $Fe_3O_4$-CLI.*

- $Fe_3O_4$ nanoparticle: 5-30 nm

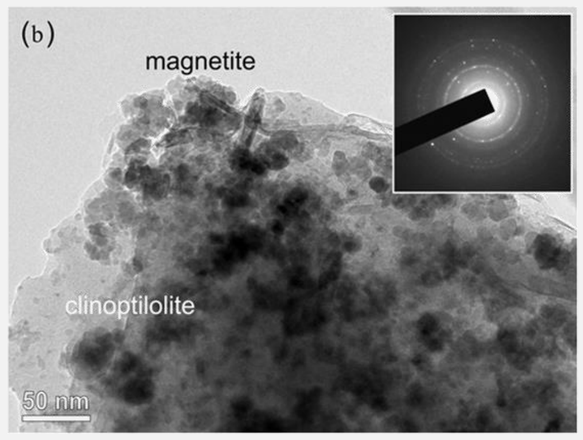



***Fig. 3*** *TEM image with SAED pattern of $Fe_3O_4$-CLI (right upper corner).*

- $Fe_3O_4$-CLI preserves magnetic properties after the CIP adsorption.

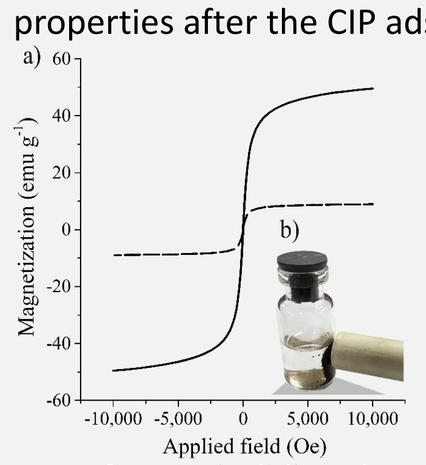
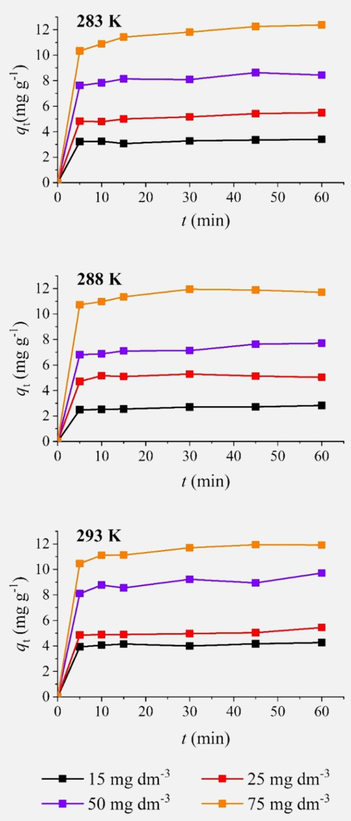



***Fig. 4*** *The a) magnetization curve of $Fe_3O_4$ (solid) and $Fe_3O_4$–CLI (dash), and b) magnetic separation of the CIP-containing $Fe_3O_4$ -CLI .*

## 3. CIP ADSORPTION TESTS

The CIP uptake increases sharply in the first 10 min of adsorption for all studied temperatures and initial CIP concentrations (Fig. 5). More than 80% of the maximum adsorption capacity was achieved within the first 10 min, indicating **fast adsorption kinetics**.

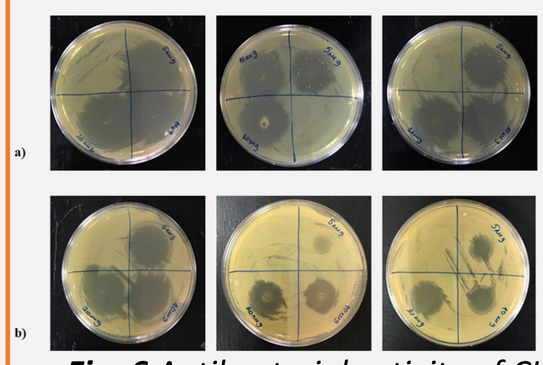



Lagergren's pseudo-second order equation

Langmuir isotherm model

***Fig. 5*** *Adsorption kinetics for CIP on $Fe_3O_4$-CLI for different temperatures and different CIP initial concentrations.*

## Possible use of the spent adsorbent




CIP-containing CLI (CIP-CLI) and $Fe_3O_4$-CLI (CIP- $Fe_3O_4$-CLI) exhibit a **strong antibacterial effect**, suggesting their possible applicability as **disinfection agents**.

***Fig. 6*** *Antibacterial activity of CIP, CIP-CLI and CIP-$Fe_3O_4$-CLI towards E. coli (a), and S. aureus (b).*

## 4. CONCLUSIONS

Natural clinoptilolite coated with nano magnetite particles is a promising adsorbent for ciprofloxacin removal from aqueous media. Spent adsorbent shows strong antibacterial properties suggesting applicability in a tertiary stage of water treatment.

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