Study of the microorganism adsorption capacity of zirconium-pillared montmorillonite particles

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INTRODUCTION

Effectively removing microorganisms from wastewater is a challenging task. The use of natural clay particles offers a cheaper, byproduct-free alternative. In this study, the microorganism binding capacity of the zirconium pillared montmorillonite (Na-Zr 2.5) was investigated under laboratory conditions, using bacterial suspension containing Gram-negative (*E. coli*) or Gram-positive (*M. luteus*) model organisms.

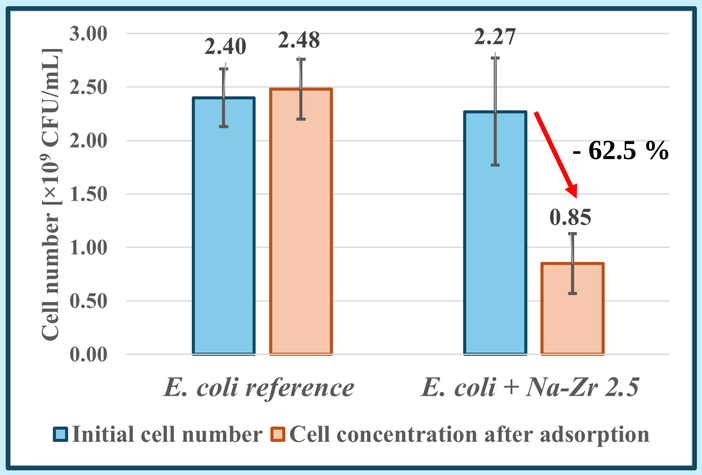

Figure 1 *Previous results of E. coli testing*

Building on our previous results (***Figure 1***), which showed 63% adsorption of *E. coli* cells, we extended the adsorption tests to other microorganisms (*M. luteus*) and compared the results with those obtained for *E. coli*. The potential to regenerate the adsorbent via heat treatment was also investigated.

METHODS FOR ADSORPTION

Bacterial cells were collected from the overnight starter culture and resuspended in physiological saline solution (8.5 g/L NaCl). The suspension was diluted to 10^6 in 30 mL volume and mixed with 30 mg of ziconium pillared montmorillonite (Na-Zr 2.5).
After incubation (1.5 h at 160 rpm continuous shaking), free cells were separated from the adsorbed cells by sedimentation (30 min). The cell concentration was determined by spreading the supernatant sample onto LB agar plates.

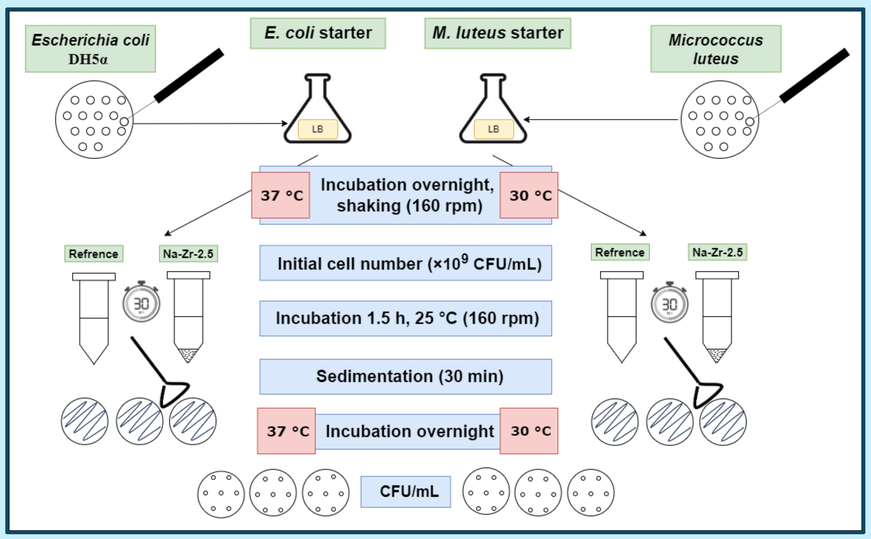

Figure 2 *Step by step flowchart of the adsorption test*

The experiments were repeated at least three times.
A reference system, containing only bacterial cells without adsorbents, was used to assess the natural settling of microorganisms in the liquid.
Figure 2 provides a detailed description of the adsorption test procedure.

RESULT OF ADSORPTION

Although the cell wall structures of *E. coli* and *M. luteus* are different, the results (***Figure 3***) showed that this did not affect their adsorption onto the surface of the tested particles. The zirconium-pillared montmorillonite clay particles bound both Gram-positive and Gram-negative bacteria with approximately equal efficiency, making them an excellent choice for wastewater treatment processes.

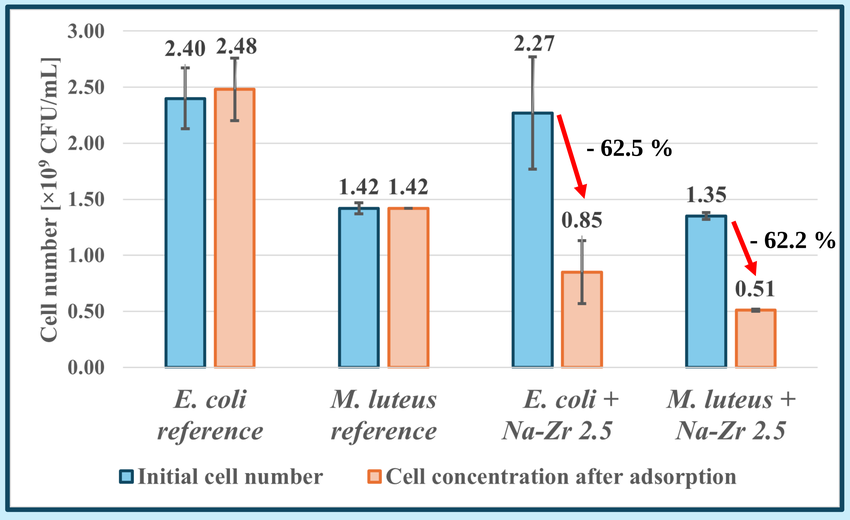

Figure 3 *Results of adsorption at 25 °C*

RESULT OF REGENERATION

For regeneration, the used adsorbent was heat-treated in a drying oven at 120°C for 5 hours, which also served as the sterilization step. The regenerated particles were added to a fresh bacterial cell suspension and tested for adsorption efficiency using the method described previously (***Figure 2***). After regeneration, the adsorption capacity remained unchanged (***Figure 4***), indicating that the adsorbent can be reused. Our future plans include applying multiple successive use-regeneration cycles and testing the adsorbent's efficiency on real wastewater samples.

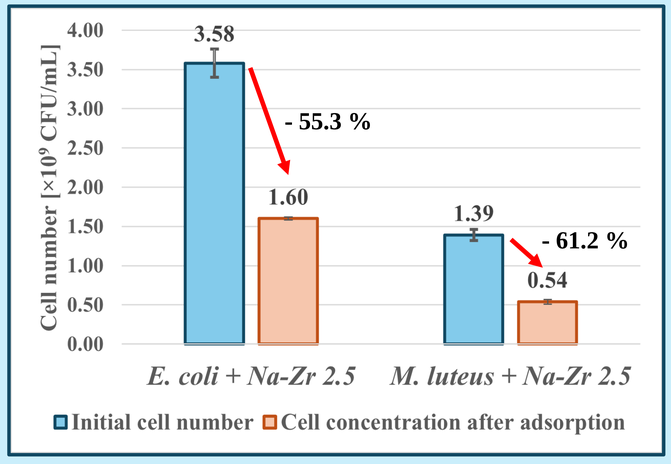

Figure 4 *Results of regeneration at 25 °C*

Reference:
T. Chauhan, E. Szőri-Dorogházi, G. Muránszky, **K. Kecskés**, M. Finsgar, T. Szabó, M. Leskó, Z. Németh and K. Hernadi,: Application of modified clays in the removal of phosphates and *E. coli* from aqueous solution, *Environmental Nanotechnology, Monitoring & Management*, **2024.**

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