Silver-modified zeolite in bioremediation of soils contaminated by *Acinetobacter baumannii*

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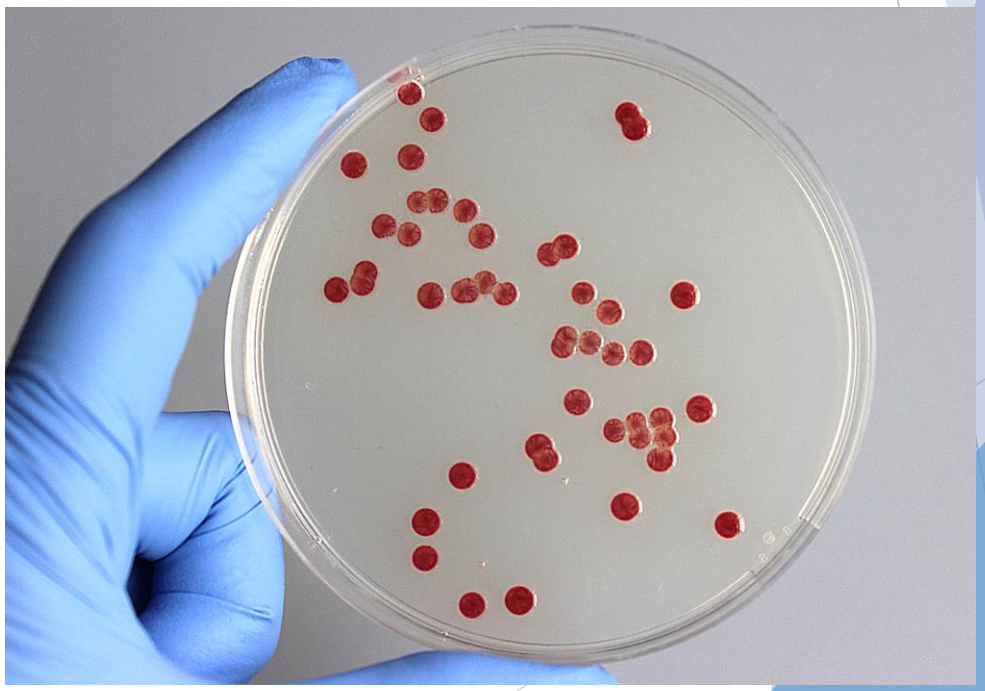
Acinetobacter baumannii

- Notorious hospital bacterium
  - pneumonia, menigitis, urinary and bloodstream infections, wound infections
- Resistance to antibiotics and disinfectants
- Persistance in the environment



NEWS

WHO “priority pathogens” list: The most dangerous bacteria in the world

The complete WHO priority pathogens list

Priority 1: CRITICAL
Acinetobacter baumannii, carbapenem-resistant
Pseudomonas aeruginosa, carbapenem-resistant
Enterobacteriaceae, carbapenem-resistant, ESBL-producing

Priority 2: HIGH
Enterococcus faecium, vancomycin-resistant
Staphylococcus aureus, methicillin-resistant, vancomycin-intermediate and resistant
Helicobacter pylori, clarithromycin-resistant
Campylobacter spp., fluoroquinolone-resistant
Salmonellae, fluoroquinolone-resistant
Neisseria gonorrhoeae, cephalosporin-resistant, fluoroquinolone-resistant

Priority 3: MEDIUM
Streptococcus pneumoniae, penicillin-non-susceptible
Haemophilus influenzae, ampicillin-resistant
Shigella spp., fluoroquinolone-resistant

A. baumannii in the environment

Hospital wastewater, wastewater treatment plants


River water

Soil

Could Silver-modified zeolite be used as a bioremediation tool to remove emerging pathogens from soil?

Experimental

- *A. baumannii* isolate EF7 recovered from effluent of the WWTP in Zagreb
- Pandrug-resistant ⇨ resistant to all tested antibiotics including carbapenems

Tested soil

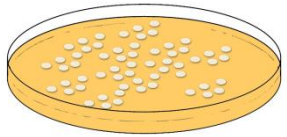
- Red palaeosol situated on Cretaceous limestone from Istria, Croatia
- Chemical composition - commercial Bureau Veritas Mineral Laboratories, Canada
- Mineral composition (fraction < 2 mm and fraction < 2 μm) X-ray powder diffraction (XRD) using a Philips diffractometer (graphite monochromator, CuKα radiation, proportional counter)

Tested zeolites

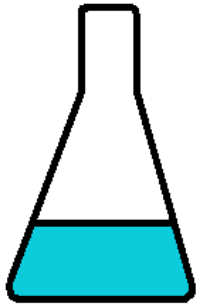
- Natural zeolitized tuff (NZ) obtained from sedimentary deposit in the Zlatokop mine, Serbia

Mineralogical composition (wt.%)	
Clinoptilolite	73
Plagioclase	14
Quartz	13

- Silver-modified natural zeolitized tuff (AgNZ) obtained by ion-exchange procedure
  - 53.78 mg Ag^+ per g of dry sample (0.50 mmol Ag^+/g)
- Both NZ and AgNZ were of particle size 0.063-0.1 mm



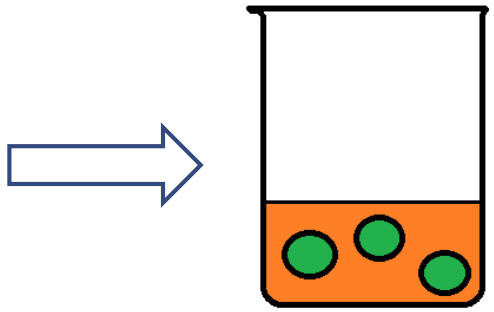
Overnight
bacterial culture



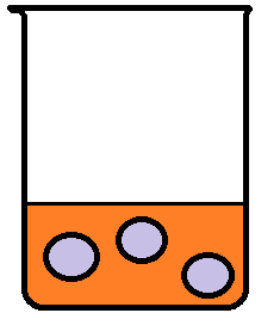
Bacterial
suspension in
spring water

Saturation of 100 g
of soil with bacterial
suspension

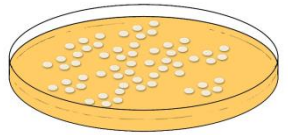
Addition of 1 wt.% NZ



Addition of 1 wt.% AgNZ



A. baumannii
36°C/24 h
CHROMAgar
Acinetobacter



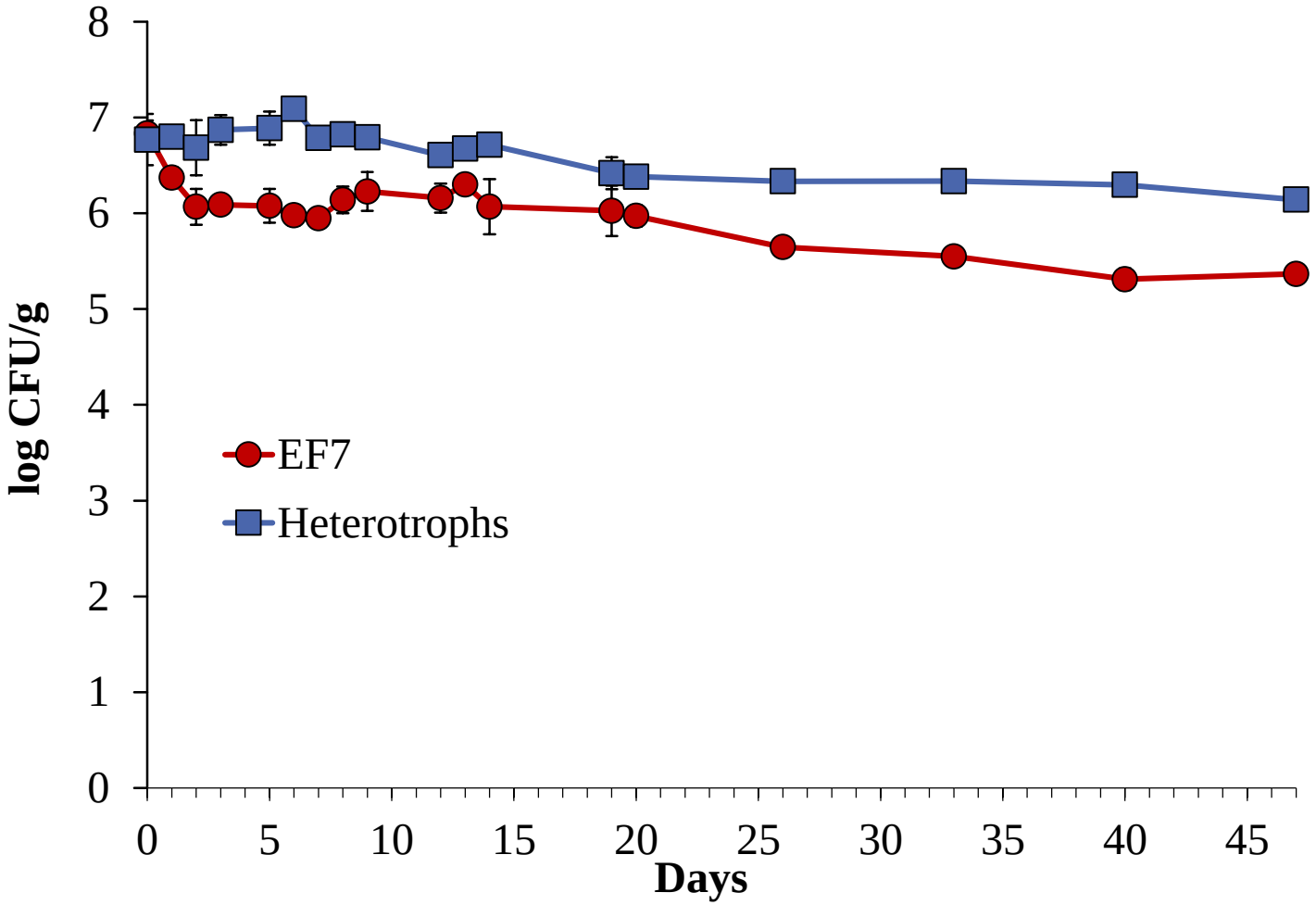
Heterotrophs
22°C/72 h
Nutrient agar

Results

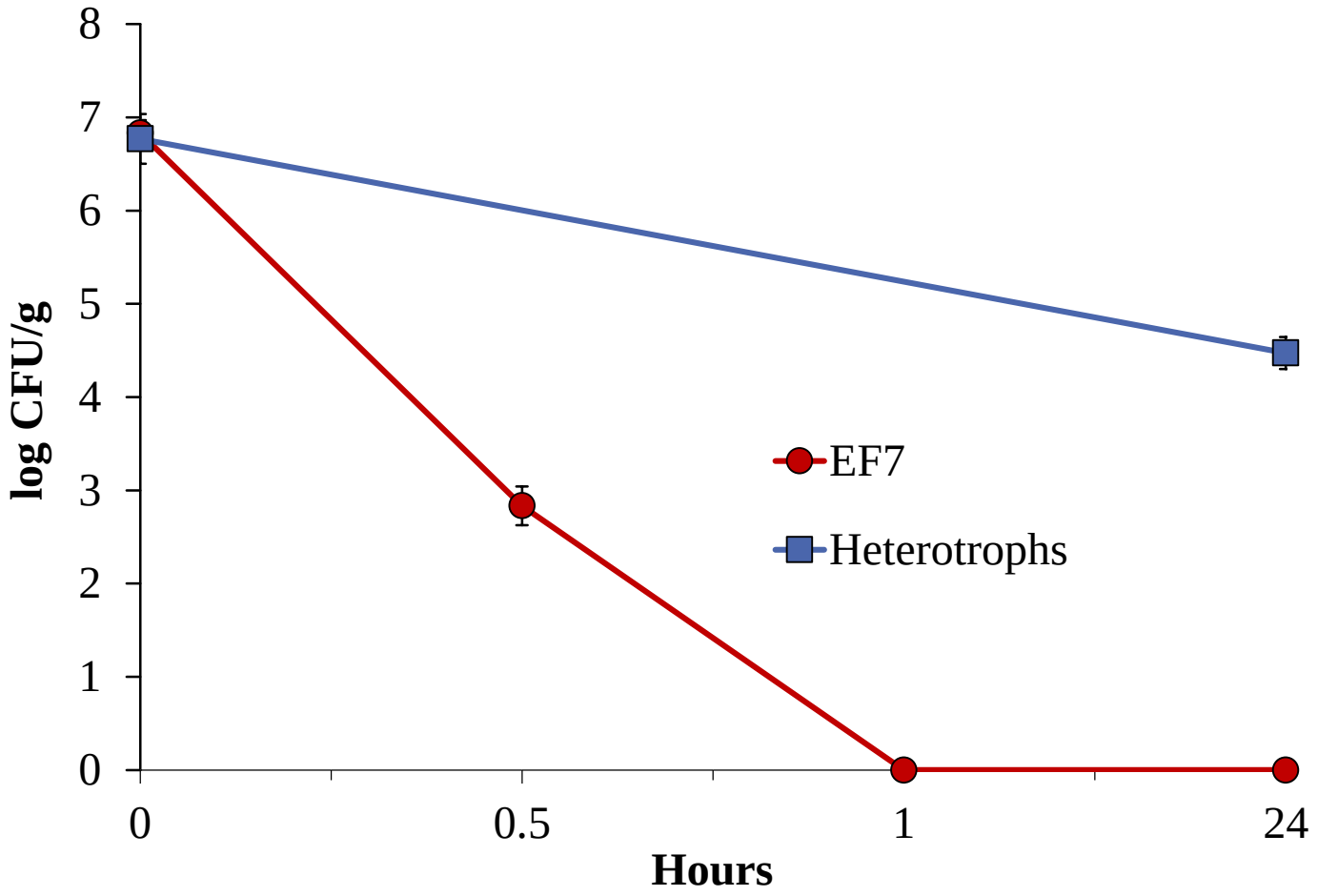
Red palaeosol pH= 8.43±0.14

Chemical composition (wt.%)	
SiO_2	57.56
Al_2O_3	15.62
Fe_2O_3	6.16
CaO	4.62
MgO	1.54
K_2O	1.72
MnO, Na_2O, TiO_2, P_2O_5	< 1

Semi-quantitative mineralogical composition	
Quartz	xxx
Calcite	x
Dolomite	x
Plagioclase	x
K-feldspar	x
Goethite	x
Haematite	x
Mica/Illitic material	xx
Kaolinite	x
Chlorite	x
14 A mineral	x
MLM	x



Survival of *A. baumannii* in red palaeosol supplemented with 1 wt.% of unmodified natural zeolitized tuff during 50 days of monitoring. Initial *A. baumannii* abundance was 6.8±0.1 log CFU/g.



Survival of *A. baumannii* in red palaeosol supplemented with 1 wt.% of Ag-modified zeolite during 24h of monitoring. Initial *A. baumannii* abundance was 6.8±0.1 log CFU/g.

Conclusions

- The addition of NZ supports the long-term survival of *A. baumannii*
- AgNZ shows remarkable bactericidal activity against *A. baumannii* after only 1h exposure, while the abundance of total native heterotrophic bacteria remains high
- AgNZ is a promising material for the bioremediation of soils contaminated with hospital pathogens

Thank you for your attention

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HRZZ
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