Parameters Regulating Microorganisms Bioremediation Potential in Soil

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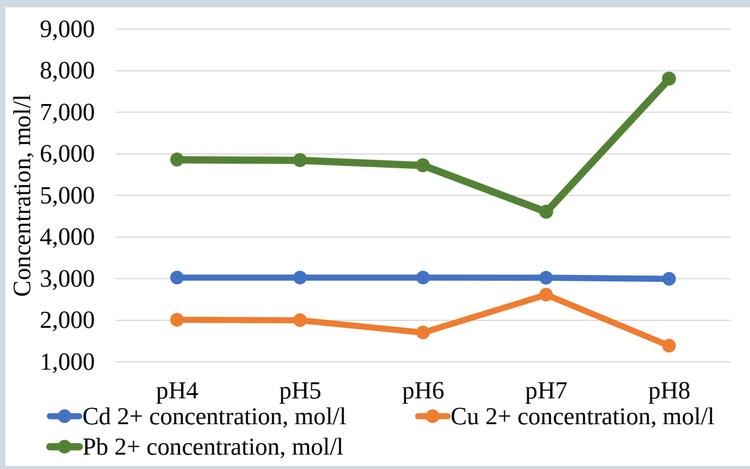
The optimal conditions for heavy metal immobilization using microorganisms are pH 7 and 30 ° C.

Keywords: heavy metal (copper, lead, cadmium), immobilization, microorganisms, soil pollution.

The Visual MINTEQ predicts metal speciation, offering fast and valuable insights into metal behaviour and fate in the environment. The concentrations of cadmium (Cd), lead (Pb), and copper (Cu) in soil are influenced by both temperature and pH. Generally, higher temperatures reduce heavy metal concentrations. Lead and copper tend to be more bioavailable and can be readily taken up by plants and animals. Cadmium is more likely to become immobilized in the soil, decreasing its biological availability. Microorganisms can be used to immobilize heavy metals, making them less mobile and less bioavailable. This biological approach contributes to safer and more sustainable soil remediation.

Cadmium, copper, lead concentration depending on pH at +30 °C.



Introduction

Soil contamination poses a threat to food safety and water quality due to heavy metal uptake.

Environmentally friendly technologies, such as microorganisms immobilization, offer effective remediation.

The process depends on soil pH, temperature, and microbial species, which heavy metals transforming from active to stable phases and reducing their bioavailability in soil.

Methodology

The Visual MINTEQ computer program can model heavy metal transformations based on pH and temperature, allowing for the identification of optimal conditions for microorganisms immobilization of these metals.

Working with the Visual MINTEQ program requires soil pH, temperature, and heavy metal concentration as input parameters (TABLE 1).

Four samples were prepared: three single-metal and one multi-metal. Samples were air-dried for two weeks. Heavy metal concentrations were measured by XRF (mg/kg) and converted to mg/L using soil bulk density (1.14 g/cm³).

Parameters	Mean
Cu^{2+}	128,8 mg/l
Pb^{2+}	143,6 mg/l
Cd^{2+}	3,65 mg/l
Cu^{2+}, Pb^{2+}, Cd^{2+}	127,7 mg/l; 121,4 mg/l; 3,4 mg/l
Temperature	from 0 to +35 ° C
pH	from 4 to 8

Research results

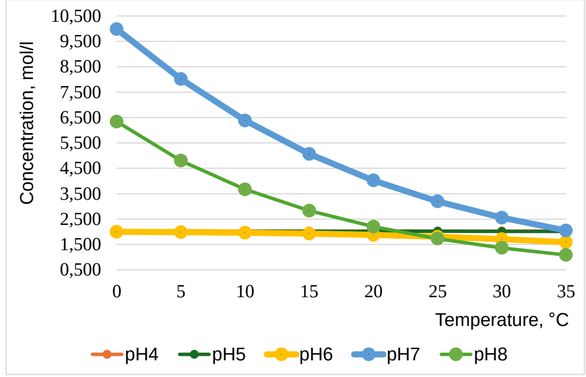


Fig. 1. Copper concentration depending on pH and temperature °C.

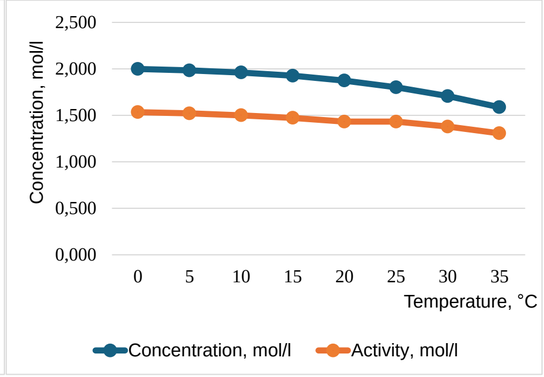


Fig. 2. Copper concentration and activity depending on temperature at pH 6.

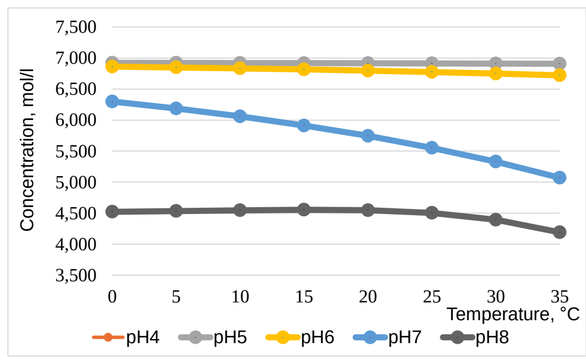


Fig. 3. Lead concentration depending on pH and temperature °C.

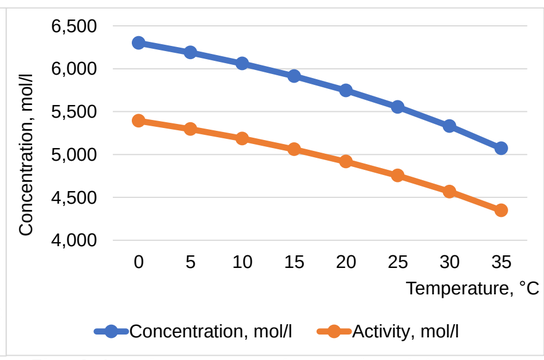


Fig. 4. Lead concentration and activity depending on temperature at pH 7.

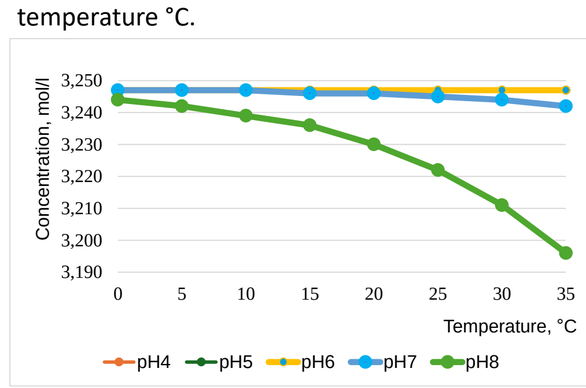


Fig. 5. Cadmium concentration depending on pH and temperature °C.

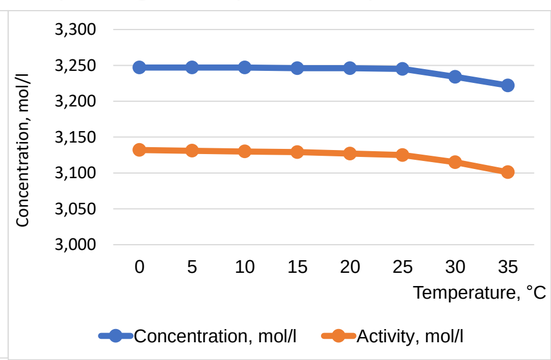


Fig. 6. Cadmium concentration and activity depending on temperature at pH 7.

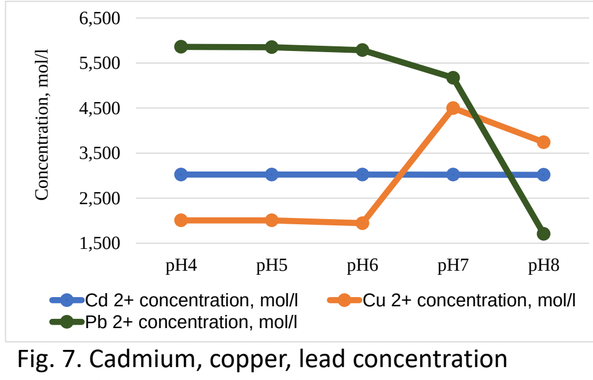


Fig. 7. Cadmium, copper, lead concentration depending on pH at +10 °C.

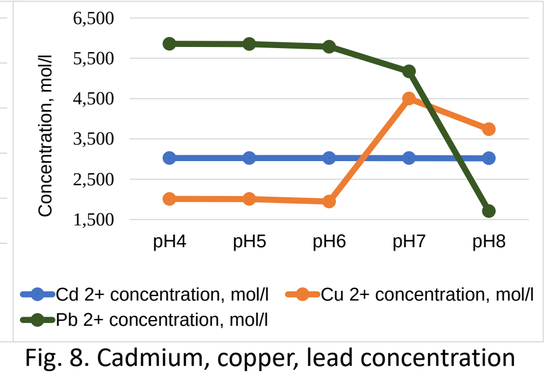


Fig. 8. Cadmium, copper, lead concentration depending on pH at +20 °C.