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THE EFFECT OF CHROMIUM, NICKEL AND LEAD NITRATE ON *LEMNA MINOR*

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Abstract: A study was conducted on the nitrate salts of three potentially hazardous metals (chromium, nickel, and lead), detailing their ecotoxicological impacts on the test aquatic organism, the common duckweed (*Lemna minor*). Two types of tests were carried out: a common duckweed growth inhibition test and a test to determine some biochemical parameters (fresh weight, chlorophyll content, concentration of reducing sugars and proteins). The first test involved testing five different concentrations of the three nitrate salts (chromium nitrate, nickel nitrate and lead nitrate) from the point of view of their ecotoxicity on duckweed, while the second test involved testing three concentrations of each nitrate. The results demonstrated that chromium and nickel nitrate had toxic effects on the duckweed at the highest concentrations tested, while lead nitrate did not affect the test plant at the five concentrations tested. The fresh weight of the plants was negatively influenced by all three tested metals at high concentrations. Regarding the chlorophyll content, the higher test concentrations induced a decrease in this parameter, except for lead nitrate. The concentration of reducing sugars was decreased only at the high concentration of chromium nitrate. Chromium and lead nitrate induced decreased protein concentration at the highest concentrations tested, while nickel nitrate induced the same effect at the lowest concentration tested. The results indicated that the toxicity of the three studied nitrates on common duckweed (*L. minor*) can be ranked as follows: $\text{Ni}(\text{NO}_3)_2 > \text{Cr}(\text{NO}_3)_3 > \text{Pb}(\text{NO}_3)_2$, nickel nitrate having moderate toxicity, while chromium and lead nitrate being practically non-toxic.

• Introduction

The term "toxic metals" usually refers to heavy metals with high atomic weight or density. Chromium, nickel and lead were selected as toxic metals of interest because they are frequently present in the environment in various forms or products. The wide range of uses of these metals allows contamination of the environment, being found in water, soil and even air. These metals can have adverse effects on both humans and the environment.

The common duckweed (*Lemna minor*) is an aquatic macrophyte that is used as a test model organism due to its small size, ease of cultivation and vegetative propagation.

• Material and method

Three types of toxic metal nitrates were tested:

- $\text{Cr}(\text{NO}_3)_3$
- $\text{Ni}(\text{NO}_3)_2$
- $\text{Pb}(\text{NO}_3)_2$

Two types of control solutions were used:

- positive control (C+, ZnCl_2 0.5%)
- negative control (C-, culture media)

The effects of the 3 types of samples were determined by using two types of tests, each of them lasting 7 days:

- a duckweed growth inhibition test
- a test to determine some biochemical parameters (fresh weight, chlorophyll content, reducing sugars, protein concentration).

• Results and discussions

Frond fresh weight was reduced at 1000 mg/L concentrations of the three nitrates, along with 1 mg/L concentration of nickel nitrate. The other concentrations did not affect the fresh weight of the fronds (**Fig. 1**). The content of chlorophyll *a*, *b*, *a+b* and carotenoids was reduced in the case of 1 mg/L and 1000 mg/L concentrations of chromium and nickel nitrate. A similar effect was also observed in the case of the concentration of 0.001 mg/L of lead nitrate, in the case of this nitrate the content of chlorophylls increased with the concentration (**Fig. 2**). The concentration of 1000 mg/L chromium nitrate resulted in a significant decrease in the concentration of reducing sugars, while the concentration of 0.001 of the same nitrate resulted in a significant increase in this biochemical parameter (**Fig. 3**). Chromium nitrate at 1000 mg/L induced a decrease in protein concentration, along with nickel nitrate at 0.001 mg/L and 1 mg/L, as well as lead nitrate at 1000 mg/L. Protein concentration was also positively influenced by 0.001 mg/L chromium nitrate and 1000 mg/L nickel nitrate. In the case of chromium nitrate, a decrease in protein concentration was observed with increasing nitrate concentration, while in the case of nickel nitrate the trend was reversed (**Fig. 4**).

According to the EPA aquatic ecotoxicity categories and based on the EC_{50} values, nickel nitrate has moderate toxicity, while chromium and lead nitrate are practically non-toxic to *Lemna minor* (**Tabel 1**).

Tabel 1- EC_{50} values and toxicity categories for the three nitrates

Compound	EC_{50} (mg/L)	Toxicity category (according to U.S. EPA)
$\text{Cr}(\text{NO}_3)_3$	126,3	Practically nontoxic
$\text{Ni}(\text{NO}_3)_2$	1,29	Moderately toxic
$\text{Pb}(\text{NO}_3)_2$	225,1	Practically nontoxic

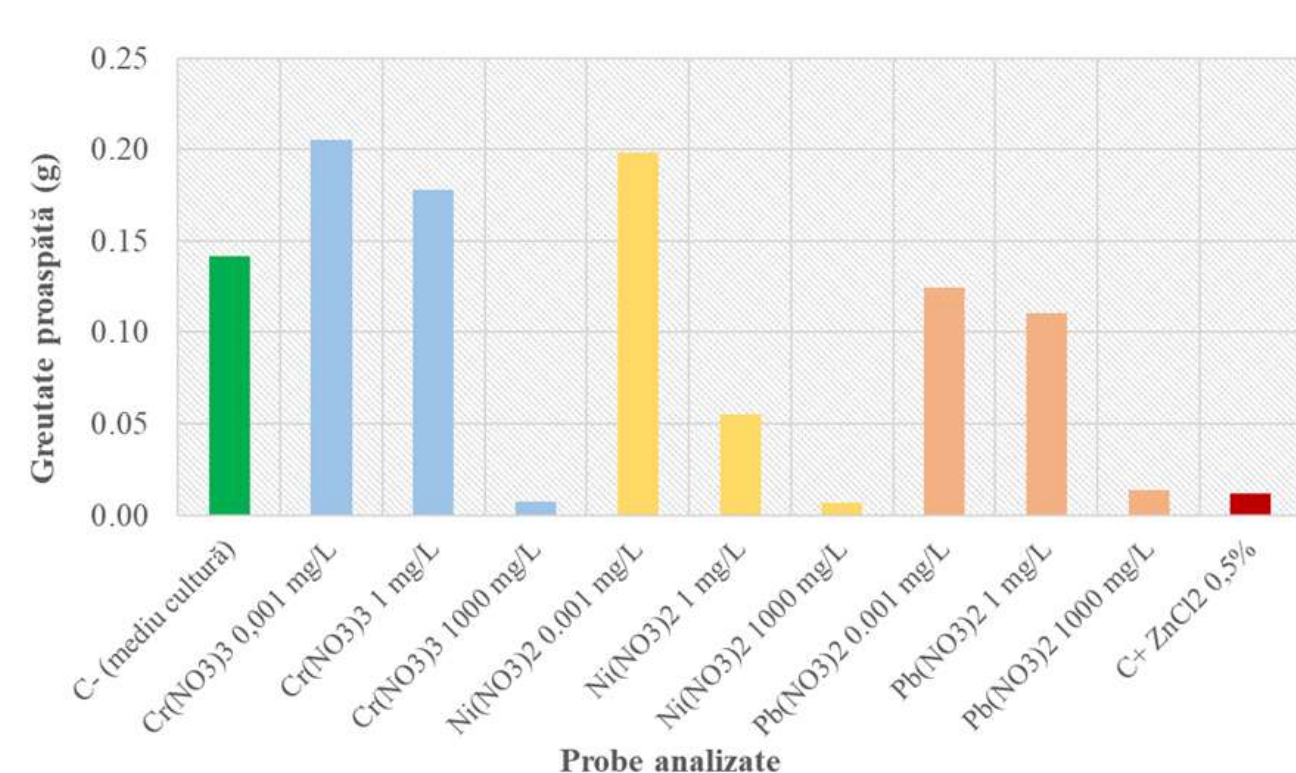


Fig. 1- The effect of the 3 nitrates on fresh weight

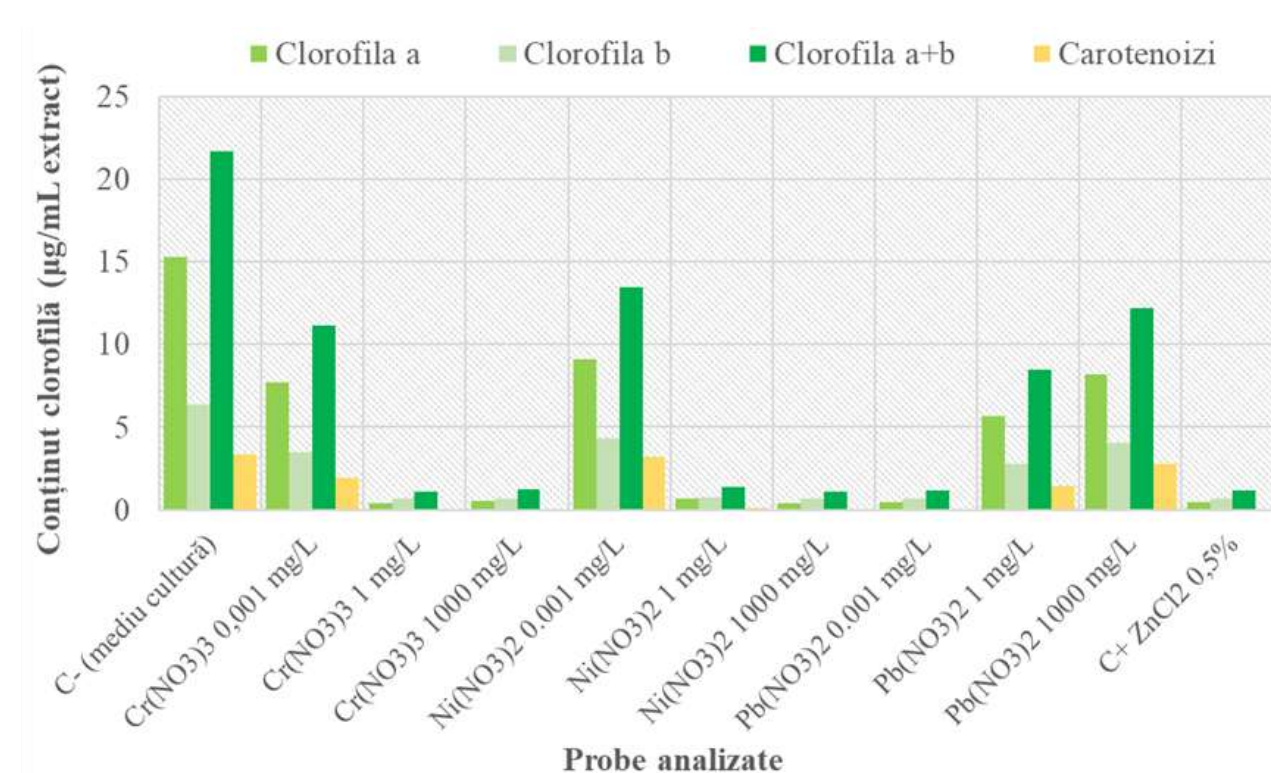


Fig. 2- The effect of the 3 nitrates on the chlorophyll content

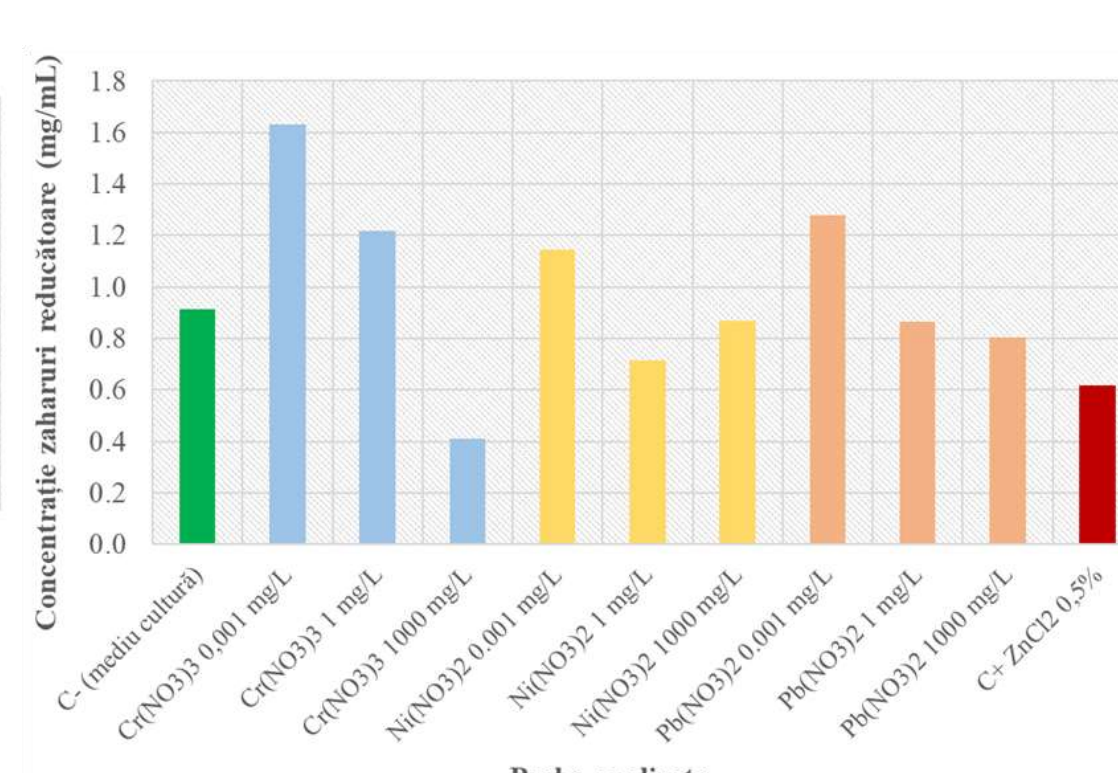


Fig. 3- The effect of the 3 nitrates on the concentration of reducing sugars

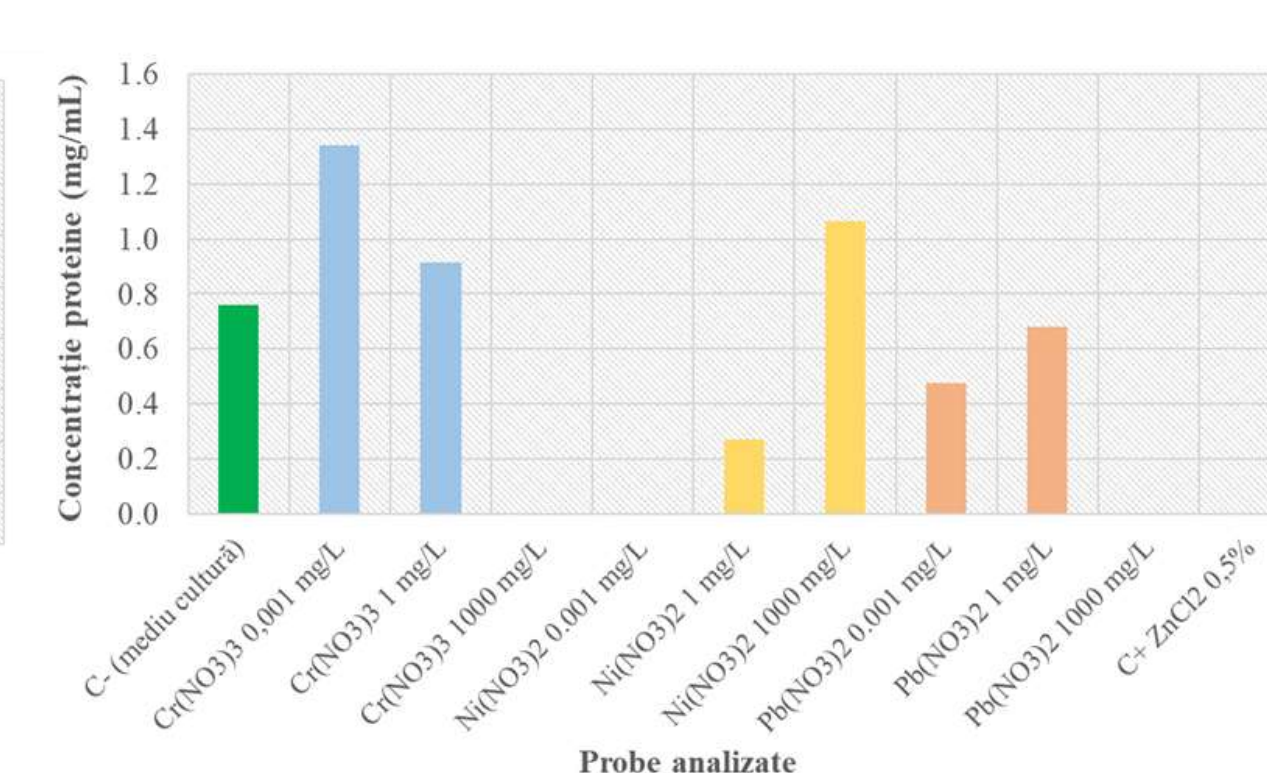


Fig. 4- The effect of the 3 nitrates on protein concentration

• Conclusions

Following the growth inhibition test performed on *Lemna minor*, it was observed that both chromium nitrate and nickel nitrate strongly inhibited plant growth, while lead nitrate did not inhibit duckweed growth. The concentration of reducing sugars was significantly reduced only at the concentration of 1000 mg/L chromium nitrate. Chromium nitrate at 0.001 mg/L induced a significant increase in the concentration of reducing sugars compared to the negative control. Regarding protein concentration, significant negative effects were observed in the case of 1000 mg/L chromium and lead nitrate concentration, as well as in the case of 0.001 mg/L nickel nitrate concentration. According to the results obtained in this study, nickel nitrate showed the highest toxicity, followed by chromium nitrate, while lead nitrate showed the lowest toxicity.