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ASSESSMENT OF THE IMPACT OF CHROMIUM, NICKEL, AND LEAD NITRATE ON THE GROWTH AND PHYSIOLOGY OF *LEMNA MINOR*

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Abstract: *The present study investigates the potential toxicity of nitrate-based salts containing chromium, nickel, and lead on the aquatic plant Lemna minor. Two separate experimental methods were used: one focusing on evaluating plant growth inhibition, and another examining physiological responses through biochemical markers, including biomass (fresh weight), pigment content (chlorophyll), and concentrations of reducing sugars and proteins. In the growth assay, Lemna minor was exposed to five graded concentrations of each metal salt to determine their toxicological effects. The biochemical analysis utilized three concentrations per compound to assess metabolic alterations. The data revealed that elevated doses of chromium and nickel nitrates impaired plant health, while lead nitrate showed no measurable effect across all tested concentrations. All three salts led to a reduction in biomass at higher doses. Notably, chlorophyll levels decreased in response to chromium and nickel exposure but remained unaffected by lead. A decline in reducing sugar content was associated solely with high chromium nitrate concentration. Protein content dropped following high exposure to chromium and lead nitrates, while nickel nitrate caused this effect even at the lowest concentration tested. Based on observed toxicity, the impact hierarchy was established as $Ni(NO_3)_2$ > $Cr(NO_3)_3$ > $Pb(NO_3)_2$, with nickel nitrate classified as moderately toxic and the others showing minimal toxicity.*

• Introduction

The phrase "toxic metals" typically describes heavy metals that have a high density or atomic weight. Since chromium, nickel, and lead are commonly found in the environment in a variety of forms or products, they have been selected as hazardous metals of interest. These metals' many applications enable environmental contamination; they can be found in soil, water, and even the air. Both people and the environment may be negatively impacted by these metals.

The aquatic macrophyte known as common duckweed (*Lemna minor*) has been used as a test model organism because of its small dimensions, ease of cultivation, and vegetative replication.

• Material and method

Three different kinds of hazardous metal nitrates have been studied:

- $Cr(NO_3)_3$
- $Ni(NO_3)_2$
- $Pb(NO_3)_2$

Two types of control solutions that were utilized:

- Positive control ($ZnCl_2$ 0.5%, C+)
- Negative control (culture media, C-)

Two types of tests were used to assess the impact of the three different sample types and each test lasted 7 days:

- A duckweed growth inhibition test
- A test to measure certain biochemical parameters (fresh weight, chlorophyll content, protein concentration and reducing sugars)

• Results and discussions

At 1000 mg/L concentrations of the three nitrates and 1 mg/L concentration of nickel nitrate, the fresh weight of the first was decreased. The fresh weight of the fronds was unaffected by the other concentrations (**FIG. 1**). At 1 mg/L and 1000 mg/L concentrations of chromium and nickel nitrate, the ratio of chlorophyll *a*, *b*, *a+b*, and carotenoids was decreased. A similar result occurred when the concentration of lead nitrate was 0.001 mg/L; in this instance, the amount of chlorophylls ascended as the concentration of the nitrate increased (**FIG. 2**). Lead nitrate at 1000 mg/L, nickel nitrate at 0.001 mg/L and 1 mg/L, and chromium nitrate at 1000 mg/L all caused a drop in protein concentration. Additionally, 0.001 mg/L chromium nitrate and 1000 mg/L nickel nitrate had a favorable effect on protein concentration. When the concentration of chromium nitrate increased, the concentration of protein decreased, but the opposite tendency was seen when the concentration of nickel nitrate increased (**FIG. 3**). The concentration of reducing sugars significantly decreased at 1000 mg/L of chromium nitrate, although this biochemical parameter significantly increased at 0.001 of the same nitrate (**FIG. 4**). Based on the EPA aquatic ecotoxicity categories and EC_{50} values indicate that nickel nitrate is moderately toxic, but lead and chromium nitrate are essentially non-toxic to *Lemna minor* (**Tabel 1**).

Tabel 1- EC_{50} values and toxicity categories for the 3 nitrates

Compound	EC_{50} (mg/L)	Toxicity category (according to U.S. EPA)
$Cr(NO_3)_3$	126,3	Essentially non-toxic
$Ni(NO_3)_2$	1,29	Moderately toxic
$Pb(NO_3)_2$	225,1	Essentially non-toxic

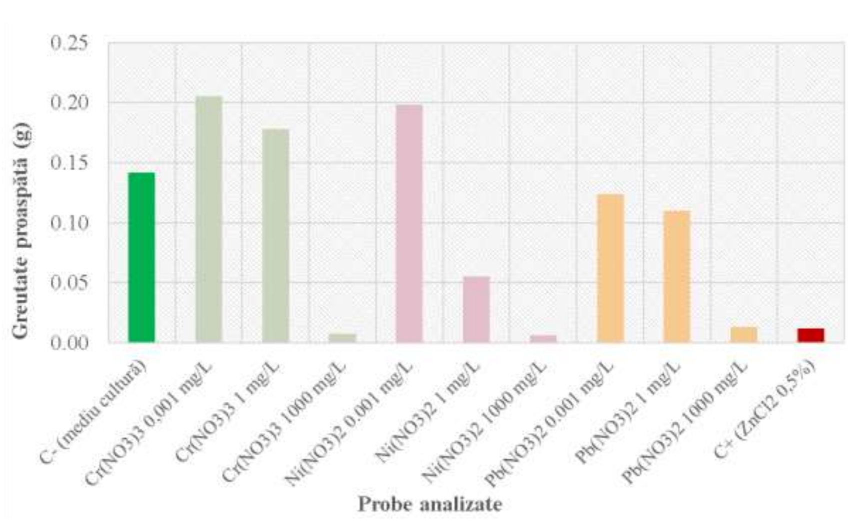

FIG. 1- The effect of the 3 nitrates on fresh weight

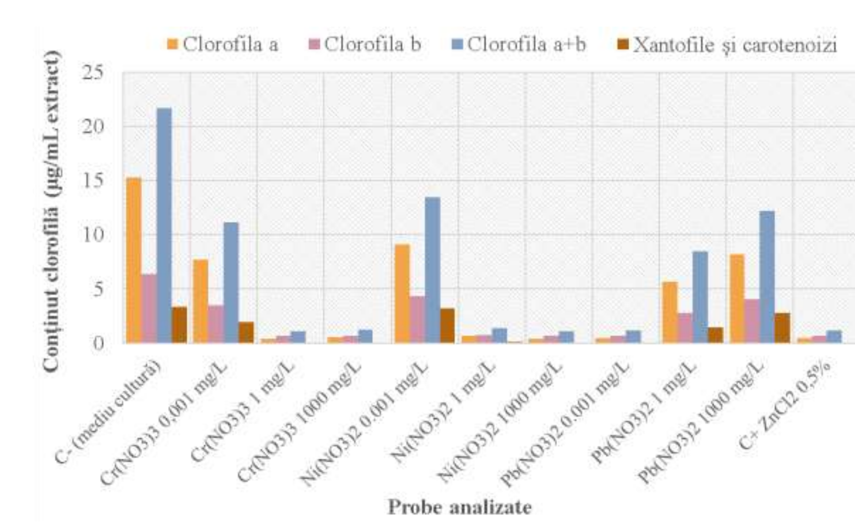

FIG. 2- The effect of the 3 nitrates on the chlorophyll content

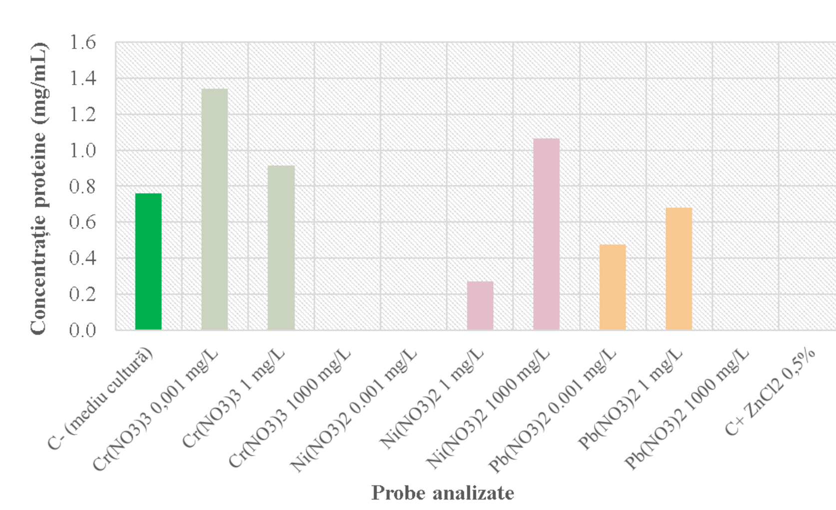

FIG. 3- The effect of the 3 nitrates on protein concentration

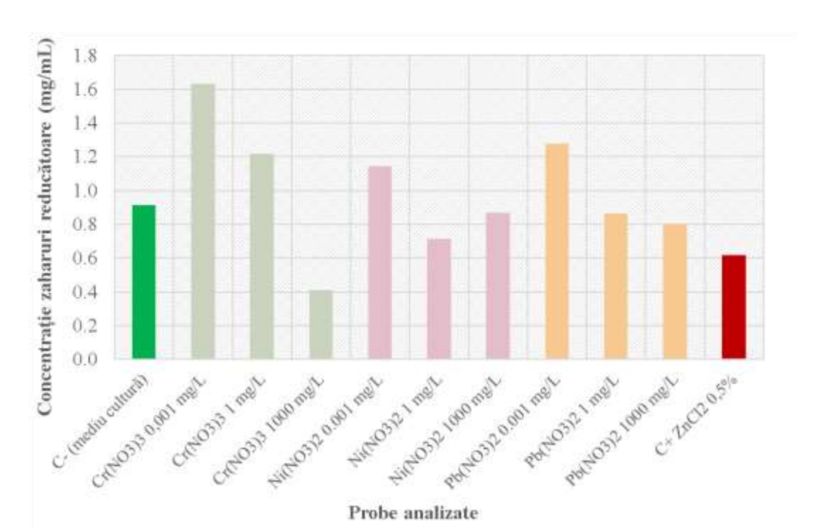

FIG. 4- The effect of the 3 nitrates on the concentration of reducing sugars

• Conclusions

According to the results of the growth inhibition test conducted on Lemna minor, lead nitrate did not limit the growth of duckweed, but both nickel and chromium nitrate significantly reduced plant growth. The concentrations of 1000 mg/L chromium and lead nitrate and 0.001 mg/L nickel nitrate showed notable negative effects on protein concentration. The concentration of reducing sugars drop noticeably only at a 1000 mg/L chromium nitrate concentration. In comparison to the negative control, a substantial increase in the concentration of reducing sugars was caused by chromium nitrate at 0.001 mg/L. The results of this study indicate that lead nitrate had the lowest toxicity, while nickel nitrate had the highest toxicity, followed by chromium nitrate.