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DETERMINATION OF MINIMUM TOXIC CONCENTRATION OF ARSENIC POLLUTANTS ON SOIL AND WATER MICROORGANISMS

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Abstract: Pollution of soils and waters with chemical compounds, including heavy metals, is currently one of the major problems with serious consequences on Biosphere. Arsenic is an element that comes into the environment from a variety of natural and anthropogenic sources. Chronic exposure to inorganic arsenic compounds increases the risk of cancer.
The main objective of this paper is to determine the minimum toxic concentration of arsenic compounds that pollute soil and groundwater on soil and water microorganisms. From the experimental data analysis, a natural resistance of water and soil microorganisms to arsenic concentrations ranging from 10 µg / L to 10 g / L was observed. The 25 g / L arsenic concentration was toxic for water and soil microorganisms and represents the minimum toxic concentration of arsenic pollutant.
Keywords: arsenic pollutants, soil and water microorganisms, antibiogram method, antibacterial activities, toxicity.

1. INTRODUCTION

Pollution of soils and waters with chemical compounds, including heavy metals, is currently one of the major problem with serious consequences on the Biosphere. Soil and water contaminated with arsenic toxic substances is a special concern [1].

Soil can be considered practically a non-renewable natural resource which has a crucial role for human activities and ecosystems survival. Soil has multiple economic and biological functions because it determines agricultural production and state of forests, conditioning plant cover as well as water quality, regulates liquid and solid leakage in river basins. Soil acts as a geomembrane to reduce air and water pollution by retaining, recycling and neutralizing pollutants, such as chemicals used in agriculture, organic waste and residues and other chemicals [1, 2].

Arsenic is an element that comes into the environment from a variety of natural and anthropogenic sources [3,4].

As arsenic is commonly found in rocks, soil or sediments, they determine the arsenic areal level in deep and surface water. Also, due to erosion, decomposition and due to atmospheric factors, arsenic can be released into groundwater and surface water [4,5].

There is clear evidence that chronic exposure to inorganic arsenic compounds increases the risk of cancer. Studies have shown that inhalation of arsenic leads to an increased risk of lung cancer. Arsenic ingestion has been associated with an increased risk of skin cancer and cancer in the bladder, liver and lungs [5, 6, 7].

The main objective of this paper is to determine the minimum toxic concentration of arsenic compounds on soil and water microorganisms.

2. MATERIAL AND METHODS

Microbiological behaviour of arsenic pollutant. Toxicity tests

The experiment was aimed to determining the minimum toxic concentration of arsenic solutions on soil and water microbiota by the antibiogram method. By this method, the minimal toxic concentration is identified by the occurrence of an inhibition zone of bacterial growth around the tablet moistened with the toxic substance.

In order to establish the microbiological behaviour of arsenic, toxicity tests using arsenic solutions with concentrations of 10, 50, 100, 200, 500, 800, 1000 As µg/ L; 10, 100, 500 mg As/L and 10 and 25 g/L were performed.Toxicity tests on heterotrophic bacteria cultures obtained from soil and Bega River water were performed. Bacteria cultures were obtained on a solid non-selective growth medium - Plate Count Agar (Peptone 10g; 10g meat extract; NaCl 5g; Agar 20g; Distilled water 1000ml. pH 7.2-7.4.), making two types of cultures: test cultures (3 repeats) – using test solutions with arsenic content and control cultures - without test solution.

Inoculation method by incorporation into Plate Count Agar growth medium, in sterile Petri dishes, which were incubated at 30^0 C for 48 hours was performed. In sterile Petri dishes 1 mL of test solution, 1 mL of bacterial inoculum and 10 mL of Plate Count Agar growth medium were introduced. In control culture, instead of the test solution, 1 mL of sterile distilled water was used.

After inoculation, the sterile filter paper for the antibiogram toxicity test was used. The filter paper soaked in the arsenic solution was placed over the

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culture medium, each of the 10 samples corresponding to a piece of filter paper soaked in arsenic solution of different concentrations. The filter paper is placed in the ascending order of arsenic concentration.

The arsenic used was in the form of a solution of As^{5+}, a solution prepared from the MercK standard of H_3AsO_4. The bacteria were grown at 30 ° C. The analyses were performed by assessing bacterial growth relative to the filter papers with different concentrations of arsenic solution, comparing with an arsenic-free control (Figure 1).

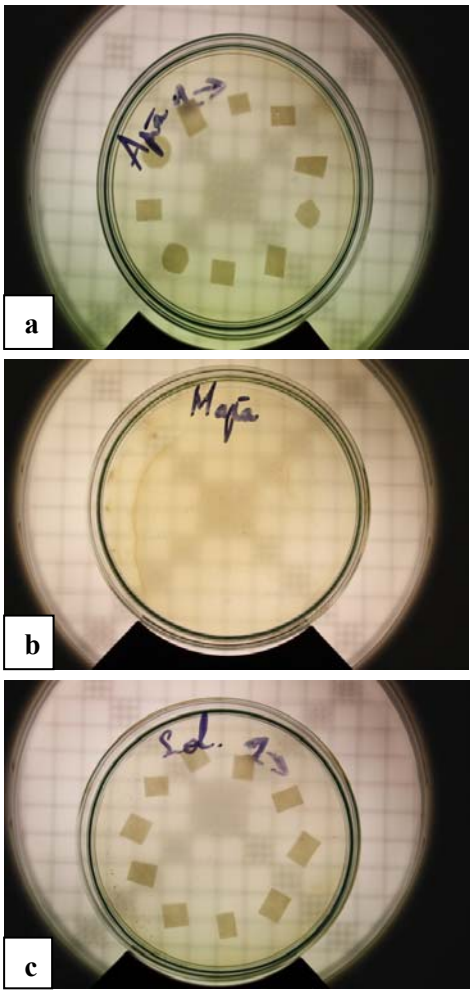


Figure 1. a. Inoculated water sample before bacterial growth (increasing arsenic concentrations); b. Control culture c. Inoculated soil sample before bacterial growth (increasing arsenic concentrations)

3. RESULTS AND DISCUSSION

Microbiological behaviour of arsenic solution. Toxicity tests.

After 48-hours incubation, a very good bacteria growth for control culture and test cultures for 10, 50, 100, 200, 500, 800, 1000 As µg/ L; 10, 100, 500 mg As/L, was observed (Figure 2). This shows that the water and soil microorganisms have a natural resistance at 10, 50, 100, 200, 500, 800, 1000 As µg/ L; 10, 100, 500 mg As/L, arsenic concentrations solutions.

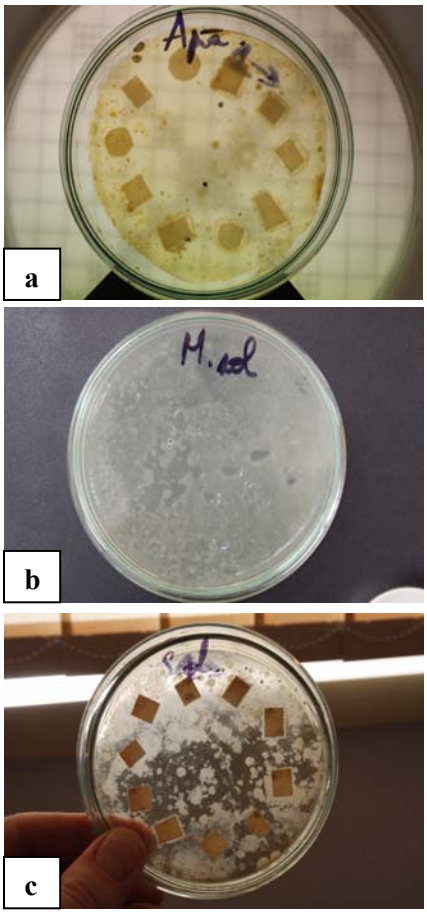
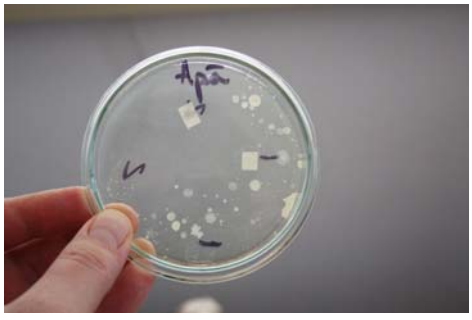


Figure 2. a. Behaviour of water microorganisms in the presence of arsenic solution; b. Control culture c. Behaviour of soil microorganisms in the presence of arsenic solution

Initial arsenic concentrations were not toxic to water and soil microorganisms.In order to determine the minimum toxic concentration of the arsenic solution it was necessary to increase the concentration using 10 and 25g As / L. At the same time, the pollutant was placed both directly on the culture media and fillet paper immersed in the solution.

After 48-hours incubation it is observed that the bacteria from both water and soil grow abundantly and are not inhibited at the first concentration - 10 g / L. Second concentration - 25 g / L, is established to be the minimum toxic concentration arsenic pollutants for water and soil bacteria with a well-visible inhibition zone (Figure 3).



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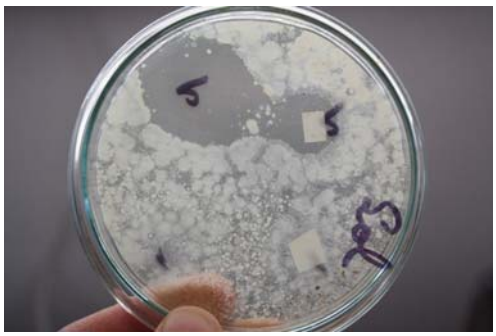

b

Figure 3. Behaviour of water (a) and soil (b) microorganisms at 10 and 25g As/L arsenic concentration

4. CONCLUSIONS

From the experimental data analysis, a natural resistance of water and soil microorganisms to arsenic concentrations ranging from: 10 µg / L to 10 g / L was observed.

The 25 g / L arsenic concentration for water and soil microorganisms is toxic and it represents the minimum toxic concentration of the arsenic pollutant.

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