Summary for the general public

The global challenge of arsenic (As) pollution, driven predominantly by anthropogenic activities, necessitates innovative solutions for environmental restoration. This project aims to advance our understanding of time-dependent accumulation and metabolism mechanisms influencing the reduction of arsenic pollution through phytoremediation, specifically dendroremediation using native tree species. Conventional cleanup methods prove costly for large affected areas, prompting a shift toward the potential of dendroremediation. Native tree species exhibit promising defence and adaptation mechanisms, making them ideal candidates for phytoremediation. Building on the success of a previous project, the researchers focus on the time-dependent responses of trees to different forms of arsenic during seed and seedling growth stages.

Previous experiments revealed clear differences in adaptation and growth among tree species exposed to various arsenic forms. The simultaneous presence of different forms affected metalloid uptake and translocation inside the plants, with concentration increases enhancing phytoextraction efficiency. Surprisingly, dimethylarsinic (DMA) was identified as the most toxic form for tree seedlings.

The main aim of the proposal is to indicate the time-dependent response processes of trees under selected As forms exposure at different stages of growth, evaluating both the seed stage and the young seedling growth phase. We will focus on plants' rapid, short-term response (measured in hours and days) and the extended, more complex response (measured in weeks and months).

The project's novel approach involves investigating the dynamics of metalloid forms uptake, accumulation, translocation, and transformation in tree organs. The researchers aim to identify correlations between arsenic translocation/transformation and tree growth stages, bioindicative traits of metabolic compounds influencing tree survivability, and the influence of root secretions on growth and metalloid accumulation. The proposed research objectives include tracing the germination stage under arsenic exposure, identifying correlations between arsenic translocation/transformation and tree growth stages, indicating bioindicative traits of biochemical compounds in tree seedlings, and exploring the influence of root secretions on growth and metalloid accumulation.

The state of knowledge underscores the significance of finding species capable of growing on highly contaminated substrates. Dendroremediation emerges as a promising technique, garnering increasing recognition within the scientific community. However, existing studies highlight the need for more accurate experimental conditions, considering the stability or changes of arsenic forms during experiments.

The proposed project addresses these gaps by focusing on the first stages of tree growth, exploring the impact of key organic compounds, such as proline and thiamine, and investigating the role of root exudates in arsenic accumulation and translocation. This comprehensive approach aims to provide valuable insights into the time-dependent mechanisms of arsenic exposure during plant growth, contributing to sustainable and effective solutions for environmental remediation.