Tropentag, September 15-17, 2021, hybrid conference

"Towards shifting paradigms in agriculture
for a healthy and sustainable future"

Ozonation to Enhance Plant Based Mining of Metals from Polluted Water

Jörn Germer, Folkard Asch

University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Germany

Abstract

Metals are introduced into aquatic systems through the weathering of soils and rocks, volcanic eruptions and a variety of human activities associated with agriculture, mining, processing or use of metals and/or metal-containing substances. Some metals such as manganese, iron, copper and zinc are essential or, like Na, non-essential micronutrients, but in high concentrations these elements can be toxic. Certain heavy metals such as arsenic, cadmium, chromium, copper, nickel, lead and mercury are known environmental pollutants due to their toxicity, persistence in the environment and bioaccumulative nature. Recent studies show that metal content in wastewater is not only a health and environmental problem, but also represents a significant economic loss.

Various methods have been used to extract metals from contaminated water. These include chemical precipitation, ion exchange, adsorption, membrane filtration, reverse osmosis, solvent extraction and electrochemical treatment. As with ore mining, the profitability of extracting metals from water increases with metal concentrations. Therefore, new approaches to concentrate water born metals can contribute to economic and environmental sustainability.

The results of our research show that ozonation of treated wastewater significantly increases deposition of metals on the roots and their uptake by hydroponically grown plants. We postulate that ozone increases the oxidation of metals and thereby their precipitation. Roots exudes protons into the rhizosphere to reduce precipitated Fe3+ for uptake. However, residual ozone seems to neutralise these protons or it immediately re-oxidises the reduced Fe. To compensate for the constant loss of protons, the roots take up other oxidised divalent metals. As a result, the contents of Fe and Zn in the roots and of Ca, Mg, Mn, Zn and Cu in the shoots doubled or tripled. The contents of the heavy metals As, Cd, Co, Cr and Pb increased accordingly. For all metals, the root content was many times higher than the shoot content.

Our poster explains the reduced Fe availability induced by ozonation and the thereby promoted metal accumulation on and in the roots and shoots of plants. The potential of this approach to unburden the environment and to mine metals from water is discussed for three tropical scenarios.

Keywords: Divalent metals, iron deficiency, ozonation, wastewater mining

Contact Address: Jörn Germer, University of Hohenheim, Inst. of Agric. Sci. in the Tropics (Hans-Ruthenberg-Institute), Stuttgart, Germany, e-mail: jgermer@uni-hohenheim.de