

The Removal of Heavy Metals using Edible Plants in Aquaponic Systems

Muhammad Aisy Jaballah Yaakub & Nurul Nadiah Mohd Firdaus Hum*

Structured Abstract

Background: This study explores the use of edible plants in aquaponic systems to remove lead (Pb) from contaminated water, addressing environmental and food safety concerns. Heavy metal pollution, particularly from industrial and agricultural sources, poses significant risks to aquatic ecosystems and human health. Aquaponics, combining aquaculture and hydroponics, offers a sustainable solution by leveraging plant phytoremediation capabilities while producing food. The research focuses on evaluating the efficiency of Pb removal using plants like kangkong, bok choy, and mustard green, alongside assessing system stability and plant health under controlled contamination.

Methods: A controlled aquaponic system was designed with fish tanks, grow beds, and water circulation components. Red tilapia were introduced to produce nutrient-rich waste, while edible plants were grown in Pb-contaminated water. Pb solutions (0–10 ppm) were prepared and introduced into the system. Weekly monitoring included Pb concentration measurements via Atomic Absorption Spectroscopy (AAS), plant tissue analysis (roots, stems, leaves), and assessments of fish health and water quality (pH, dissolved oxygen, nutrients). Key metrics like Bioaccumulation Factor (BAF) and Translocation Factor (TF) were calculated to evaluate Pb uptake and distribution in plants.

Results: The system achieved Pb removal efficiencies exceeding 96%, with peak efficiency reaching 99.62% by Week 4. Kangkong demonstrated the highest Pb accumulation (39.1 mg/kg in roots by Week 5), while bok choy showed lower uptake, making it safer for consumption. Pb concentrations in water decreased consistently, with minimal translocation to edible plant parts ($TF < 1$). Water quality stabilized over time, though Week 1 data exhibited variability due to initial system adjustments.

Conclusion: The study confirms aquaponics as an effective method for Pb remediation, with edible plants like kangkong offering high uptake potential. The system's closed-loop design ensures sustainable water purification and food production. Future research should optimize plant selection, extend monitoring periods, and explore scalability for industrial applications. This approach aligns with global goals for environmental sustainability and food security.

Keywords: Aquaponic System, Heavy Metal Removal, Phytoremediation, Edible Plants, Atomic Absorption Spectroscopy (AAS)

*Correspondence: nurulnadiyah@uitm.edu.my

^a School of Chemistry & Environment, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia