Natural Coagulation for Clean Water: A Moringa Oleifera Based Treatment System for Low-Resource Communities

Soluna Stojanovska, Ryan Oatley

Priority Topic Area: **Water and Sanitation**

Aim

Over 2 billion people lack access to safe drinking water, directly undermining UNSDG 6 and IChemE's Water and Sanitation priority topic. Conventional treatment chemicals are costly, infrastructure-dependent, and unavailable in low-resource settings. EcoSeed Purifiers is a startup concept addressing this through applied chemical engineering: utilising Moringa oleifera (MO) seed powder to neutralise particle surface charge, reducing turbidity from over 40 NTU to below 5 NTU, enabling effective ceramic filtration and chlorination. This gravity-fed, electricity-free system requires no synthetic inputs, and MO's abundance across sub-Saharan Africa and Asia ensures local sourcing where need is greatest. Its application to microplastic removal represents a novel, scalable, low-cost solution for households and relief organisations worldwide. [1] [2] [3]

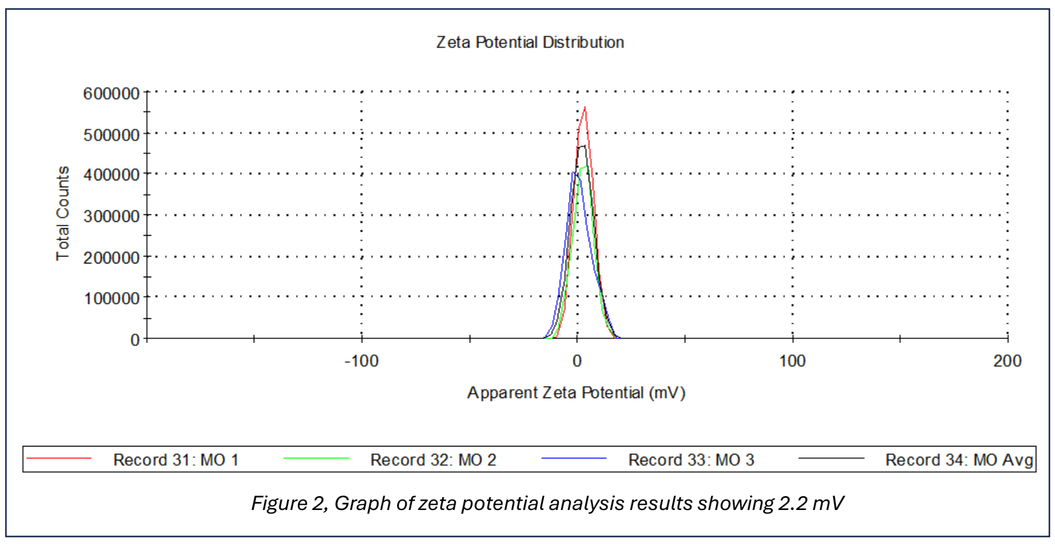


Figure 2, Graph of zeta potential analysis results showing 2.2 mV

Initial Results - Coagulation Efficiency and Charge Neutralisation

Zeta potential analysis of MO returned 2.2 mV, near the ideal 0 mV, confirming its viability as a natural coagulant. At optimal dosage (5 - 10 mg/L), MO neutralises the negative surface charge of microplastics, promoting aggregation and achieving up to 98% removal of an initial microplastic (PVC) concentration of 200 mg/L . Above this range, MO overdosing reverses particle charge to positive, causing re-agglomeration and reduced removal. These results establish 5 - 10 mg/L as the reliable peak-performance dosing window. Currently at TRL 3, reproducible laboratory-scale jar testing validates the core process chemistry, with prototype manufacture and focus group trials planned as the next steps toward a deployable field solution.

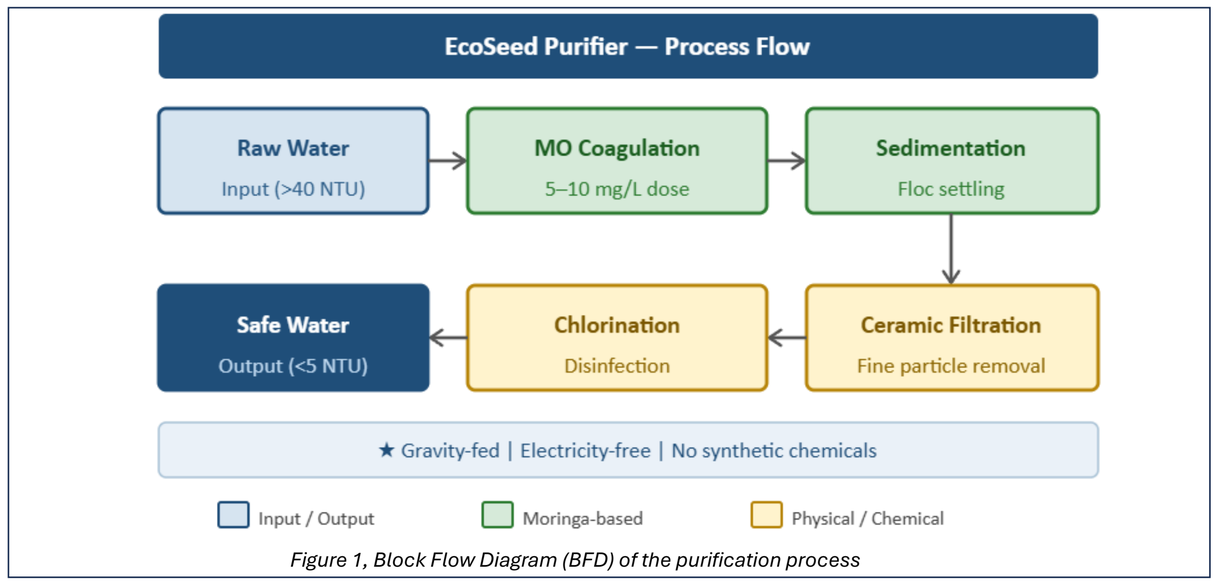


Figure 1, Block Flow Diagram (BFD) of the purification process

How It Works

The EcoSeed Purifier uses three stacked 20 L modules, each serving a distinct treatment stage:

- **Stage 1, Coagulation:** A hand-crank drives a bevel-gear right-angle stage into a 4:1 spur increase, rotating a 2-blade 90 mm pitched impeller. Moringa seed powder (5 - 10 mg/L) is flash-mixed at 300 RPM then slow-flocculated at 40 RPM. A perforated sieve plate rotates open to drain clarified water.

- **Stage 2, Ceramic Filtration:** Gravity drives water through an O-ring-sealed ceramic membrane fitted into the base, removing bacteria, protozoa, and fine particulates.

- **Stage 3, Disinfection:** A chlorine tablet (0.2 - 0.5 mg/L Cl_2) is added via a side port and safe water is dispensed via a laser-cut tap outlet. [4]

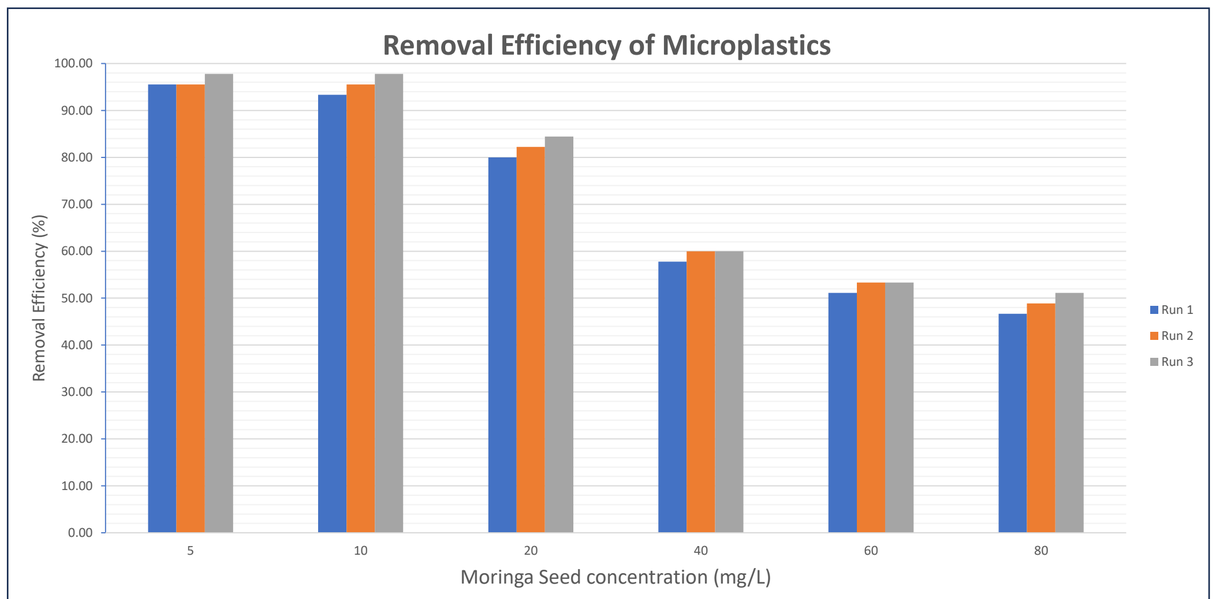
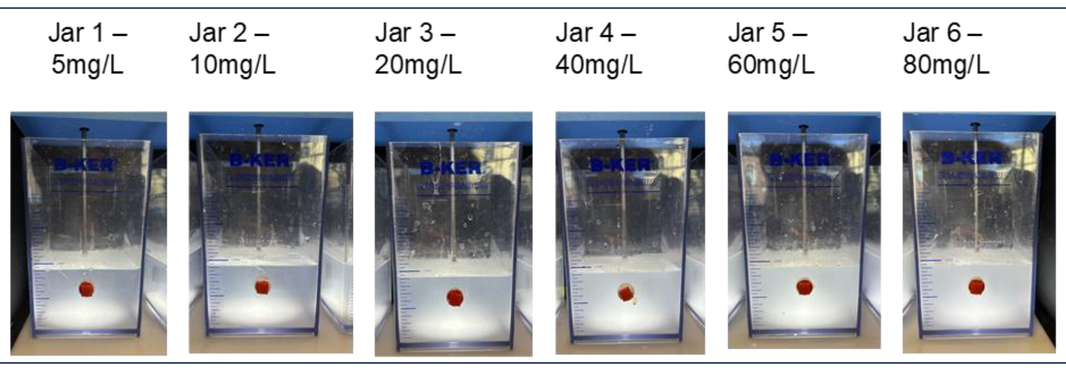


Figure 3, Chart of % microplastic removal efficiency for varying MO coagulant concentrations used.



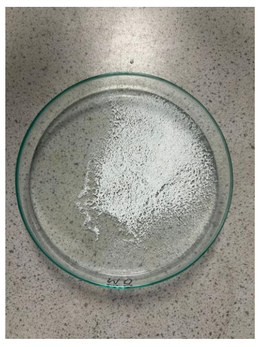


Figure 4, Jar tests demonstrating the effect of varying MO dosage on turbidity, with visible differences in water clarity across concentrations. (L)

Figure 5, Microplastic flocs formed through MO coagulation, captured following vacuum filtration. (R)

Benefit to society

By replacing synthetic coagulants with a naturally abundant, biodegradable material, EcoSeed eliminates chemical supply chain dependency, a critical barrier in low-income and disaster-affected communities. Its electricity-free design enables rapid deployment where infrastructure has failed. Up to 98% microplastic removal at optimal dosage demonstrates meaningful public health impact, and the overall system can achieve turbidity below 1 NTU, meeting WHO guidelines for safe chlorination. Reducing microplastic discharge further protects aquatic ecosystems in ecologically sensitive regions.

Next steps

Key challenges including consistent field dosing, community uptake, and affordable scale-up will be addressed through 3D-printed prototype manufacture and real-world testing, heavy metal removal evaluation, and focus group trials to assess usability and inform the final design.

Figure 6, Image of prototype concept

References/Acknowledgements

The authors gratefully acknowledge Dr Maryam Asachi, School of Civil Engineering, University of Leeds, for her invaluable guidance and supervision throughout this research.

[1] Pritchard, M., et al. "A Study of the Parameters Affecting the Effectiveness of Moringa oleifera in Drinking Water Purification." Physics and Chemistry of the Earth, vol. 35, no. 13–14, 2010, pp. 791–797.
[2] Avazpour, Saeid, and Masoud Noshadi. "Enhancing the Coagulation Process for the Removal of Microplastics from Water by Anionic Polyacrylamide and Natural-Based Moringa oleifera." Chemosphere, vol. 358, June 2024, p. 142215.
[3] Hounsinou, Parfait Sagnon, et al. "New Method of Producing a More Efficient Coagulant for the Treatment of Water from Seeds of Moringa oleifera." MethodsX, vol. 11, 2023, p. 102485
[4] World Health Organization. Guidelines for Drinking-Water Quality, 4th ed. WHO Press, 2011.