The Control of Pathogens in Stored Rainwater using Direct Electrochemical Activation

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Purpose of study or research hypothesis

The main study aim was to control waterborne pathogens using small-scale direct electrochemical activation.

Key issue(s) or problem(s) addressed

Rainwater harvesting systems enable households or communities to increase the quantity of freshwater available throughout dry periods. The biological quality of stored rainwater can be variable where storage containers are open to contamination from the environment. Improving the biological quality of stored rainwater would reduce the potential for diarrhoeal diseases that lead to deaths, prohibit people from working, or children attending school. Although rainwater harvesting is classified as an improved water source, 30% of the global population lack access to safely managed improved water sources.

Methodology or approach used

Rainwater samples collected within 100L containers (UWE Bristol's Frenchay campus) were transferred and stored within 20L laboratory glass tanks (n=5) at room temperature (20 to 22°C). A prototype direct electrochemical cell (Centrego Ltd, UK) was used to electrochemically activate the collected rainwater for a 4-hour period. Physicochemical (pH, conductivity and oxidation reduction potential) and biological (heterotrophic bacteria and total coliforms) parameters were collected every 30 minutes over the 4-hour activation period.

Results or conclusions derived from the project

Total viable coliforms recovered from rainwater prior to activation were 31.87 ± 24.43 CFU 100 mL^{-1} (n = 15). After 30 minutes of electrochemical activation [ECA] no coliforms were recovered from the treatment tank compared to 25.73 ± 24.51 CFU 100 mL^{-1} recovered from control (no treatment) tanks (n=5). Initial heterotrophic bacteria density was 4.98 ± 0.23 log_{10} CFU mL^{-1} prior to ECA, whist after 30 minutes of activation, 0.62 ± 0.70 log_{10} CFU mL^{-1} were recovered. In comparison, 5.06 ± 0.41 log_{10} CFU mL^{-1} of heterotrophic bacteria were recovered from the control tank (n=5). Viable bacterial counts (coliforms and heterotrophic bacteria) remained low throughout the 4-hour ECA period.

Implications of the project relevant to congress themes

This study has demonstrated that rainwater storage containers can have high biological loading, resulting from environmental contamination. The presence of coliforms within rainwater prohibits its use as drinking water in which only zero coliforms are permissible. Implementation of suitable low-cost technologies, capable of sustainable decentralisation (e.g. solar powered) can improve resilience for households and communities that are disproportionately affected by poor access to safely managed improved water sources. Ultimately, such approaches can mitigate disease by improving the quality of available drinking water sources.

Keywords : Decentralised Drinking Water; Direct Electrochemical Activation; Pathogen Control; Rainwater Harvesting