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Greywater treatment using constructed wetlands modified with biochar and ceramic media

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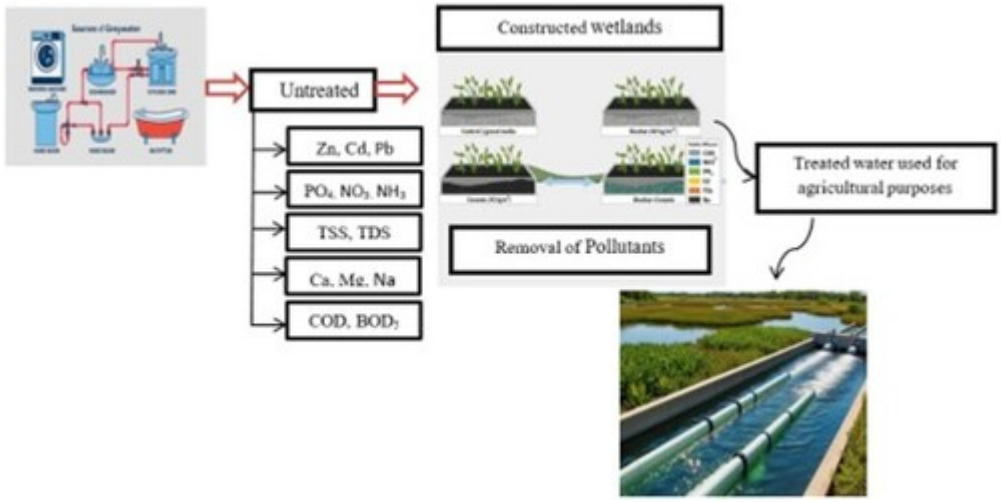
ABSTRACT

Constructed wetlands (CWs) offer an affordable and sustainable solution for decentralized wastewater treatment. This study assessed horizontal subsurface flow CWs (HSSFCWs) supplemented with charcoal and ceramic media for greywater treatment in Basra, Iraq. This novel approach demonstrates significant advancements in the removal efficiency of contaminants from greywater. Four pilot-scale wetlands were run for 182 days. *Bacopa monnieri* was planted in the wetlands. Regular sampling of influent and effluent analyzed organics, nutrients, and heavy metals. Biochar significantly improved the removal of chemical oxygen demand (COD),

(NH3), lead (Pb), zinc (Zn) and cadmium (Cd), while ceramic media enhanced total suspended solids (TSS) and total dissolved solids (TDS) removal. The combined biochar-ceramic wetland showed the highest reduction in calcium (Ca), and magnesium (Mg). Plant growth was unaffected by amendments. The treated greywater met irrigation reuse standards, highlighting the efficacy of these amendments in improving greywater quality. Biochar and ceramic media CWs exhibited superior pollutant removal compared to the control, with biochar achieving removal efficiencies of 75.60% for COD, 22.61% for NO_3-N, 90.37% for PO_4-P Ceramic media recorded the highest removal of TSS (66.99%) and TDS (50.50%). The mixed media wetland achieved the highest removal of BOD_5 (54.96%) and hardness ions. The study concludes that biochar and ceramic media are cost-effective amendments that enhance CWs for greywater treatment, supporting sustainable water reuse in small communities. These findings support the implementation of enhanced CWs for improving greywater quality and meeting irrigation guidelines.

GRAPHICAL ABSTRACT



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KEYWORDS:

Greywater treatment constructed wetlands filter pollutant removal environmental sustainability

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Supplemental Material

Supplemental data for this article can be accessed http://doi.org/10.1080/09593330.2025.2530790.

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