

APPLICATION OF POMEGRANATE PEEL IN REMOVING HARDNESS

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Reverse osmosis (RO) is highly effective in removing hardness from drinking water. However, excessive water wastage as RO brine, removal of beneficial elements and high energy consumption are challenges that need to be addressed. This study investigated the use of fruit peel-based biosorbents as a sustainable and cost-effective alternative for the reduction of groundwater hardness. Groundwater samples with an initial total hardness of $650 \pm 20 \text{ mg L}^{-1}$ were collected from a dug well at the University of Vavuniya. Five different fruit peels; beetroot, lemon, orange, banana, and pomegranate, were tested in both raw and phosphoric acid-treated forms for their hardness removal potential. Preliminary data identified phosphoric acid-treated pomegranate peel as the most effective biosorbent with the dose of 2.0 g L^{-1} at 360 min contact time. Batch adsorption experiments were carried out using different biosorbent doses ($0.1 - 10 \text{ g L}^{-1}$) and contact times (15 – 1440 min). The phosphoric acid-treated pomegranate peel achieved a maximum hardness removal of 73% at an optimum dose of 8.0 g L^{-1} at 240 min contact time. The adsorption data closely followed Freundlich adsorption isotherm ($R^2 = 0.82$) and the pseudo-second order kinetics model ($R^2 = 0.92$), suggesting a chemisorption mechanism with the maximum adsorption capacity of 200 mg g^{-1} . Column studies supported these findings, with breakthrough curves fitting well with the Yoon-Nelson and Thomas models at different flow rates (0.33, 3.00, and 6.00 mL min^{-1}). However, a slight deviation was noted at higher flow rates. The results demonstrate the effectiveness of phosphoric acid-activated pomegranate peel as a low-cost, eco-friendly biosorbent for hardness removal, as phosphoric acid treatment enhances porosity and introduces surface functional groups that improve ion exchange characteristics and adsorption capacity. This approach offers a sustainable alternative for rural water treatment systems and promotes the ‘waste to resource’ concept by utilising agricultural waste materials.

Keywords: Adsorption, Biosorbents, Groundwater, Hardness removal, Pomegranate peel