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Research Article

Feasibility study of nitrate surface adsorption by mineral pumice from nitrate solution on a laboratory scale

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Extended Abstract

Introduction
The increasing global population and unsustainable water consumption have exacerbated water scarcity, necessitating innovative solutions for water reuse in agriculture. Greywater reuse is one such strategy, but conventional treatment methods are often costly and generate sludge, making them less feasible. This study explores the feasibility of using pumice, a low-cost and abundant mineral, as an adsorbent for nitrate removal from aqueous solutions. The research aims to evaluate the efficiency of pumice in adsorbing nitrate under varying conditions, including particle size and contact time, to provide a cost-effective solution for water treatment.

Materials and Method
The study employed a factorial experimental design with two factors: nitrate solution and pumice particle size (1 cm, 5 cm, and a layered mixture of 1–5 cm). The experiment was conducted over 45 days, with nitrate concentrations measured using spectrophotometry at a wavelength of 470 nm. Pumice samples were prepared by crushing, sieving, and washing to remove impurities. The adsorption capacity of pumice was evaluated by measuring nitrate removal efficiency at different time intervals. Statistical analysis was performed using SAS software to assess the impact of particle size and contact time on nitrate adsorption.

Results and Discussion
The results demonstrated that pumice effectively adsorbed nitrate from the solution, with the highest removal efficiency observed for 1 cm particles. On the 20th day, the nitrate concentration decreased from 0.88 g/L to 0.62 g/L, indicating a removal of 0.36 g/L. Larger particle sizes (5 cm and layered 1–5 cm) showed maximum adsorption on the 30th day, with reductions of 0.19 g/L and 0.27 g/L, respectively. The smaller particle size (1 cm) achieved a 41% reduction in nitrate concentration, while the layered and 5 cm particles achieved 31% and 22% reductions, respectively. The study highlighted that smaller particle sizes and increased surface area enhanced adsorption efficiency. However, degradation of the pumice structure over time led to the release of adsorbed nitrate back into the solution, particularly after the 20th day for 1 cm particles and after the 30th day for larger particles.

Conclusion
This study confirms that pumice is a cost-effective and efficient adsorbent for nitrate removal from aqueous solutions. Smaller particle sizes (1 cm) exhibited the highest adsorption capacity, but degradation occurred earlier compared to larger particles. To prevent nitrate release, treated water should be discharged before pumice degradation begins. Additionally, spent pumice can be repurposed as a soil amendment or fertilizer, further enhancing its sustainability. These findings suggest that pumice is a viable option for nitrate removal in agricultural wastewater treatment, offering a low-cost and environmentally friendly solution to water scarcity challenges.

Keywords: Surface absorption, Water pollution, Pumice, Nitrate solution