

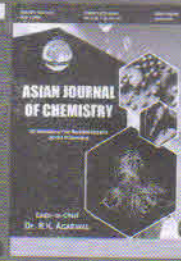


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Adsorption of Ammonium Ions from Water using Activated Carbon Derived from Garlic Waste

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Water contaminated with ammonium (NH_4^+) is associated with many adverse effects on humans, aquatic organisms and the environment. The removal of NH_4^+ from aquatic sources is essential to support life. This study used modified garlic basal plate waste to remove NH_4^+ from polluted water. Garlic waste was carbonized at 450°C and chemically activated with NaOH and H_3PO_4 . After activation, the samples were characterized using SEM, EDX, TEM, XRD, FTIR and Raman spectroscopy. The SEM images showed that the inner surface was exposed and was heterogeneous and, porous with cavities of different sizes and shapes. The elemental constituents of the materials are carbon (C), oxygen (O) and heteroatoms in trace amounts. FTIR analysis showed that the materials have many functional groups, such as $-\text{OH}$ (3250 cm^{-1}), $-\text{CH}$ (2916 cm^{-1}), $-\text{C}=\text{C}$ and $-\text{NH}_2$ groups (1658 cm^{-1}), $-\text{OH}$ (1425 cm^{-1}) and $-\text{CO}$ (1000 cm^{-1}). Equilibrium studies indicated that the data fit the nonlinear Freundlich model, suggesting that the uptake represents multilayer adsorption due to different active sites on the adsorbent with unequal energy levels. The Freundlich constant (n) values were between 4.276 and 5.902, indicating that the uptake was favourable. The contact time effect showed three different phases of adsorption: a strong uptake, a steady state of adsorption and a plateau. The data for the contact time corresponded to the pseudo-second order kinetic model. The ΔH° values ranged from -1.27 to -5.04 kJ/mol , indicating that the uptake was dominated by physical adsorption, but to some extent other mechanisms were partially involved in the uptake. The values of ΔS° and ΔG° were also negative, indicating that the adsorption was spontaneous and only partially random. The optimal conditions for the uptake of NH_4^+ using a working standard with an initial concentration of 100 mg/L were a solution pH of 10 and a temperature of 298 K . Under these conditions, the adsorption capacities for untreated carbon from garlic basal plate (CGBP), acid activated garlic basal plate (AGBP) and base activated garlic basal plate (BGBP) were 25.09, 37.04 and 40.11 mg/g , respectively.

Keywords: Garlic basal plate waste, Activated carbon, Adsorbents, Ammonium ions.