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Adsorptive Studies of Toxic Lead Ions and Methylene Blue from Aqueous Solution by Black Eyed Beans

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Abstract: *In this study Black eyed beans were used for the removal of toxic Pb(II) ions and methylene blue dye from aqueous solution. The use of Black eyed beans in water treatment application is largely unexplored. Therefore the current study is the first ever to report on Black eyed beans as potential adsorbents. Black eyed beans were tested as adsorbents in pristine and chemically treated form. Batch adsorption experiments were conducted to evaluate the effect of systematic parameters such as the initial concentration, temperature, contact time and pH. The adsorbents were characterized by scanning electron microscope (SEM), thermogravimetric analysis (TGA), X-ray diffraction (XRD), fourier transformed infrared (FTIR) and Brunauer-Emmet teller (BET). SEM images revealed that acetone treated Black eyed beans (Ac-MB), methanol treated Black eyed beans(Me-MB) and dimethyl formamide treated Black eyed beans(DMF-MB) morphologies were dominated by spherical microstructures. FTIR analysis affirmed the presence of oxygen containing functional groups such as (–OH), (–COOH) and (–C]O) attached to the adsorbents surface. These groups could enhance the adsorption processes. BET results also suggested that treated Black eyed beans exhibits large pores, which could easily trap Pb(II) ions and methylene blue dye. It was observed that uptake of Pb(II) and methylene blue increased with increase in initial concentration of solution. However, all adsorbents had higher adsorption capacity for methylene blue molecules than Pb(II) ions. Also adsorption rate of methylene blue was faster, achieving equilibrium in 20 min and Pb(II) ions in 90 min. Enhancing the temperature of the solution had a positive effect on the removal of Pb(II) ions by UT-MB and AcMB, while for methylene blue it was Me-MB and Ac-MB revealing the exothermic nature of the processes. However, increasing the temperature was detrimental on the adsorption of Pb(II) ions onto Me-MB, AA-MB and DMF-MB, for methylene blue it was onto DMF-MB, UT-MB and AA-MB revealing the endothermic nature of the processes. The maximum adsorption capacities were obtained at pH 9 for both pollutants, Pb(II) adsorption capacity trends were UT-MB > Ac-MB > DMF-MB > AA-MB > Me-MB (19.96, 18.94, 17.60, 16.17 and 16.15 mg/g) respectively and for methylene blue were Me-MB > DMF-MB > UT-MB > Ac-MB > AA-MB (24.56, 23.89, 22.86, 22.78 and 22.55 mg/g). Pb(II) adsorption onto all adsorbents fitted Freundlich model. Methylene blue adsorption onto UT-MB and Ac-MB fitted Langmuir model, while Me-MB, AA-MB and DMF-MB fitted Freundlich model. Kinetic studies revealed that all adsorption processes found good fit for PSO model. However, Pb(II) ions adsorption onto AA-MB and DMF-MB had good fit for PFO model.*

Keywords: Black eyed beans

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