Processing of a Novel Low-Cost Adsorbent by Co-granulation of Egg-Shells and Tea Waste

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In this work, egg shells and tea waste were used during the co-granulation process with different mass fractions for the production of low cost efficient adsorbents to remove Methylene Blue (MB) from aqueous solutions. The main aim of this research was to process novel low-cost adsorbent by co-granulation of egg shells and tea waste. Specific objectives were to optimize color removal conditions by varying different mixing ratios of tea waste and egg shell and pH, to develop adsorption isotherm and adsorption kinetic model. Seven types of co-granules were produced by mixing mass fractions of tea waste and egg shells as 1.0:0.0, 0.8:0.2, 0.6:0.4, 0.5:0.5, 0.6:0.4, 0.8:0.2, 0.0:1.0 respectively. UV/Vis spectrometer (DR6000-HACH®) was used to measure concentrations. Maximum wave length of MB was 665nm. The adsorption data were fitted to Langmuir and Freundlich isotherms and adsorption parameters were determined using Newtons least square method. Equilibrium concentration data were fitted to the Langmuir isotherm model with high R-square value than Freundlich isotherm model. Therefore, Langmuir isotherm is the best fitted model for this adsorption process. Type 1 (tea to egg shell ratio is as 1.0:0.0) granules showed the maximum adsorption capacity. For type 1 co-granules, the Langmuir constants q_m and b were determined as 0.21 mg/g and 6.73 L/mg and Freundlich constants K_F and (1/n) were 0.16 ((mg/g) (l/mg)$^{0.49}$) and 0.26 respectively. When mass fraction of tea waste increases, density decreases and specific surface area increases. Pseudo first order kinetic model is best for some types of co-granules and second order kinetic model is best for other types. When pH of initial solution increases, adsorption capacity increases. The zero-point charge (pH_{zpc}) for tea waste was determined around 5.0. Surface of tea waste is negatively charged at higher pH values creating electroststic attraction between negatively charged surfce and MB cationic ions.

Keywords: Co-granulation; Egg shell; Tea waste; Methylene blue