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Simultaneous removal of basic dyes from binary systems by modified orange peel and modeling the process by an intelligent tool

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ABSTRACT

This study presents the consecutive modification of orange peel (OP) by NaOH and sodium dodecyl sulfate (SDS) for simultaneous elimination of basic dyes from the binary system and modeling the adsorption process using an intelligent tool. The natural and modified biosorbents were characterized by variety of analyses such as: field emission scanning electron microscopy with energy dispersive X-ray, N_2 physisorption and Fourier transform infrared spectroscopy techniques. The influence of various variables on dye removal like pH, the quantity of biosorbents, dyes concentration, contact time, and temperature in the binary system were investigated and optimized by an artificial neural network (ANN) model as an intelligent tool. The optimum quantity of the sorbent was found to be 0.30 g for orange peel (OP) and 0.25 g for NaOH-treated OP (NOP) and SDS-decorated NOP (SNOP) at pH = 7. The kinetics and thermodynamics investigations showed that the removal of dyes obeyed the pseudo-second-order kinetic model and were spontaneous and exothermic in nature. Moreover, in order to describe the mechanism of sorption process, desorption studies of dyes were carried out. The desorption percentages of methylene blue (MB) in water and HCl were found to be in the range of 1.93%–4.76% and 18.87%–28.76%, respectively; in addition, the desorption percentages of crystal violet (CV) in water and HCl were obtained to be in the range of 4.11%–7.41% and 32.84%–43.00%, respectively; which could be a recommendation ion exchange or electrostatic attachment of dyes onto biosorbents. The ANN predictions matched with the experimental data very well ($0.95308 < R^2 < 0.99191$ and $0.98335 < R^2 < 0.99773$ for MB and CV, respectively) which indicated high accuracy of the ANN model. In addition, the relative importance of each parameter was calculated by Garson's equation.

Keywords: Binary system; Surfactant modification; Orange peel; Artificial neural network modeling.

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