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Utilisation of Cationic Surfactant Modified Kaffir Lime Leaves Residue for the Removal of Reactive Orange 16 Dye from Aqueous Solution: A Fixed-Bed Column Study

Nur Hannan Batrisyia Eusud[a], Shariff Che Ibrahim[a*]

Structured Abstract

Background: The removal of reactive orange 16 (RO16) dye using residue as a non-conventional low-cost adsorbent will be studied. Column adsorption will be used to demonstrate how parameters such as adsorbent bed height and intake dye flow rate affect the results. The adsorption data were fitted to the Yoon-Nelson model for predicting breakthrough curves and timings. The time necessary for a breakthrough in Yoon-Nelson model will be set at 50% of the effluent RO16 to feed concentration. The correlation coefficients, R^2, for all two parameters will be used to determine the efficacy of the adsorbent in extracting RO16 from aqueous solution.

Methods: An adsorbent made from kaffir lime leaves will be chemically treated with cationic surfactant which is cetyltrimethylammonium bromide (CTAB) to remove RO16 using continuous adsorption approach on a fixed-bed column. The adsorbent's morphological characteristics and functional group of the raw kaffir lime leaves (RKL) and modified kaffir lime leaves (MKL) will be analysed using a scanning electron microscope (SEM) and Fourier Transform Infrared (FTIR) spectroscopy.

Results: The bed height was increased from 1 to 3 cm, the breakthrough time (t_b) values increase from 7.9 to 22 minutes. Based on breakthrough curves, increasing the bed height increases the breakthrough time. The breakthrough time was reduced from 26.1 minutes to 4.4 minutes, while the flow rate increased from 0.5 to 2 mL/min. The contact duration of RO16 in the column was shortened at higher flow rates, resulting in a lower breakthrough time.

Conclusion: This anionic dye removal is significantly influenced by column parameters such as bed height and flow rate as the plotted breakthrough curves obtained from experimental data were similar to the typical breakthrough curve. When applied to the Yoon-Nelson model, the adsorption data provided the best fit with the R^2 value above 0.95.

Keywords: Kaffir lime leaves, Reactive orange 16 dye, Cationic surfactant, Fixed bed column, Yoon-Nelson model

*Correspondence: sha88@uitm.edu.my

[a]School of Chemistry and Environment, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia