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High removal of crystal violet dye and tetracycline by hydrochloric acid assisted hydrothermal carbonization of sugarcane bagasse prepared at high yield

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ABSTRACT

At a moderate thermal treatment process, hydrothermal carbonization (HTC) was known as an alternate and green way of preparing carbonaceous material known as hydrochar as an adsorbent. The HTC process requires the inclusion of water as a carbonization medium for the hydrolysis reaction to occur. By adding acid to the HTC water, the hydrolysis reaction was catalyzed, which lowered the reaction time and temperature while also increasing the adsorption efficiency. Overreaction, on the other hand, may occur, lowering the yield as well as the number of functional groups accessible for adsorption. Thus, in this study, Response Surface Methodology by Central Composite Design (RSM-CCD) was employed to investigate and optimize the HCL acid-assisted HTC of sugarcane bagasse (SB) process parameters of loading rate, reaction time, reaction temperature, and HCL acid concentration towards three responses: optimized hydrochar (HC_{op}) yield, crystal violet (CV) dye removal and tetracycline (TC) removal. The HC_{op} was characterized using FTIR, FESEM, BET + N_2 gas, and TGA analyses, and the results were compared to hydrochar made without the use of acid (HC_{dw}). In brief, HC_{op} has more acidic oxygenated functional groups, stronger aromaticity and hydrophobicity, greater porosity, and greater thermal stability than HC_{dw}. The Langmuir isotherm model reported maximum adsorption capacity (Q_{max}) of CV dye removal for HC_{op} (207.16 mg g^{-1}) was 1.5 times higher than the HC_{dw} (137.85 mg g^{-1}). While HC_{op} had a two-fold higher Q_{max} of TC removal (68.25 mg g^{-1}) than HC_{dw} (33.61 mg g^{-1}). Overall, the optimization of HCL-acid assisted HTC of SB was successful in producing hydrochar with good adsorption efficiency.

List of symbols & abbreviations

Å	angstrom
A_{HJ}	Harkins-Jura isotherm constant
ANOVA	analysis of variance
A_T	maximum binding energy

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