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Adsorption Phenomenon for Removal of Pb(II) via Teff Straw based Activated Carbon Prepared by Microwave-Assisted Pyrolysis: Process Modelling, Statistical Optimisation, Isotherm, Kinetics, and Thermodynamic Studies

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ABSTRACT

Eragrostis tef (Teff) is one of the most important staple crops in Ethiopia. The straw obtained from teff is a plentiful source of lignocellulosic biomass. In the present study, straw obtained from teff grass was exploited as a carbon precursor to synthesise the activated carbon via chemical activation followed by microwave-aided pyrolysis. The prepared activated carbon by microwave aided method from teff straw (MATSAC) was utilised as a bio-adsorbent to examine the lead II ions adsorption potential from the aqueous medium. RSM technique was employed to explore a process model which correlates the four independent variables namely Pb(II) ions initial concentration, MATSAC dose, adsorption time, and solution pH. Further, the model was statistically optimised to achieve optimum Pb(II) ions removal. They were discovered to be Pb(II) ions initial concentration: 94.35 mg/L, MATSAC dose: 0.655 g/100 mL, adsorption time: 87.6 min, and solution pH: 5.4 to achieve the maximised removal of Pb(II) (90.89%). In the investigation on the models of isotherm, it was inferred that Langmuir isotherm fitted excellently to the equilibrium data of the adsorption. The adsorption capacity of Pb(II) on MATSAC was 42.97 mg/g. In addition, the kinetic analysis confirmed that the process of adsorption was statistically significant to pseudo 2nd order. The thermodynamic study indicated that the negative value of ΔG^{o} deep-rooted the practicability and spontaneity of MATSAC for Pb(II) ions removal. In a nutshell, MATSAC, which is derived from locally available agricultural waste, can remove toxic Pb(II) ions from contaminated water at a minimal cost.

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KEYWORDS
Teff straw activated carbon; adsorption; process optimisation; kinetics; isotherm; thermodynamics

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