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A Study of the adsorption of oxalic acid on carbonized tea waste prepared under different heat treatment conditions

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Carbonized materials are produced by various types of carbon precursors using chemical as well as physical methods. In this study, spent tea leaves, a waste and easily available low cost material, was used as the raw material for the preparation of carbonized material. The objective was to produce carbonaceous material from tea waste by application of heat and investigate the adsorption equilibrium, isothermal and kinetic studies of adsorption of oxalic acid on the carbonized tea waste. Carbonization was carried out at 350 °C for 30 min and 45 min to produce two types of carbonized tea waste. The adsorption isotherms of Langmuir, Freundlich, Temkin, and Dubnin-Radushkevich (D-R) and kinetic models; pseudo first order, pseudo second order, intra particle diffusion, liquid film diffusion, and Elovich models were used to study the behavior and characteristics of oxalic acid adsorption to the carbonized tea waste. All the studies were carried out at five different temperatures 30 ºC, 40 ºC, 50 ºC, 60 ºC, and 70 ºC. The best fit for the Langmuir isotherm suggests that the adsorption of oxalic acid onto carbonized tea waste is a monolayer adsorption process for a homogeneous surface. The maximum adsorption capacities were obtained using Langmuir isotherm. The 45 min Carbonized tea waste showed the maximum adsorption capacity of 107.5 mg g^{-1} at 40 ºC. The maximum adsorption capacity for 30 min carbonized tea waste is 95.2 mg g^{-1} at 70 ºC. The pseudo second order kinetic model well fitted with the adsorption process, having correlation coefficient values of 0.9989 and 0.9663 for 30 min carbonized tea waste and 45 min carbonized tea waste respectively suggesting that the chemisorption mechanism is predominant. The results also revealed that the adsorption of oxalic acid onto carbonized tea waste is feasible and spontaneous. However, at 350 ˚C, when the carbonization time was increased from 30 min to 45 min the process changed from endothermic to exothermic with declined randomness. The presence of functional groups hydroxyl, carboxyl, carbonyl and amine in the carbonized tea waste was confirmed by FTIR studies. The surface characteristics such as the roughness, presence of micropores and mesopores as revealed by SEM-Eds technique may cause a favourable adsorption. In spite of the required high carbonization temperature and time heat treated carbonized tea waste points out to have adsorption characteristics similar to commercially available activated carbon according to this study.

Keywords : Carbonized tea waste, Adsorption isotherms, Adsorption kinetics, Heat treatment, Oxalic acid