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Effects of the Heat Treatment on Oxalic Acid Adsorption to the Biochar Prepared from "Gurupiya" Rice Husk

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Abstract

Rice husk is a surplus agricultural waste product that is becoming a base adsorbent for water contaminants removal. It is a cost-effective material and a renewable resource as a good bio-sorbent. Oxalic acid is a by-product of complex organic compounds and is more stable than other organic compounds. Acute exposure to oxalic acid irritates the stomach, reduces blood calcium level, and affects the kidney and nervous system. In this study, the applicability of biochar prepared from a rice husk obtained from a traditional red pericarp rice variety, "Gurupiya" to remove aqueous oxalic acid was studied. Biochar was prepared by pyrolyzing the rice husk in a muffle furnace at 350° C in two different heating periods 30 and 45 minutes while nitrogen was supplied at a 200 ml/min flow rate to maintain the oxygen-free environment. The carbonized material produced from rice husk was physiochemically characterized, and the equilibrium, isotherm, and kinetic studies on adsorption of oxalic acid onto rice husk charcoal experimented. The results were compared using percentage removal of oxalic acid using activated charcoal obtained from the laboratory. The percentage yields of the prepared biochar were between 31%-34%. Functional groups on rice husk adsorbents were characterized using Fourier transform infrared spectroscopy and revealed that the samples have hydroxyl, carbonyl, silica functional groups favoring chemisorption. X-ray diffraction patterns depicted the disappearance of the crystallinity nature of the materials when increasing the heating time. The behavior of oxalic acid adsorption to the carbonized rice husk was studied using the adsorption isotherms Langmuir, Freundlich, and Temkin at three different temperatures 30±2° C, 40±2° C, and 50±2° C. The higher correlation coefficient values and the maximum adsorption capacities were obtained for the Langmuir isotherm model. The maximum adsorption capacities were 65.35 mgg^{-1} and 67.71 mgg^{-1} for two samples at 50±2° C. The adsorption process was best fitted for the Langmuir isotherm suggesting monolayer adsorption for homogeneous surface and well fitted for pseudo second-order kinetic model explaining a chemisorption mechanism. Results reveal that the adsorption process was more favorable with increasing temperature. The adsorption of oxalic acid onto rice husk charcoal is a feasible, spontaneous and exothermic process.

Keywords: Rice husk, Biochar, Oxalic acid, Adsorption, Isotherms