

## **BIOCHAR KULIT SINGKONG TERIMPREGNASI Mn<sub>3</sub>O<sub>4</sub> UNTUK ADSORPSI ZAT WARNA KRISTAL VIOLET**

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### **INTISARI**

Telah dilakukan penelitian penggunaan *biochar*-Mn<sub>3</sub>O<sub>4</sub> sebagai adsorben zat warna kristal violet. Penelitian terdiri dari sintesis *biochar* kulit singkong, impregnasi *biochar* dengan Mn<sub>3</sub>O<sub>4</sub>, karakterisasi adsorben menggunakan instrumen XRD, FTIR, SEM-EDX, dan SAA, serta studi adsorpsi kristal violet dengan metode batch. Parameter yang mempengaruhi kinerja adsorpsi berupa pH larutan, massa adsorben, waktu kontak, dan konsentrasi awal adsorbat dipelajari untuk mengetahui kondisi optimum adsorpsi. Konsentrasi zat warna kristal violet sebelum dan sesudah adsorpsi diukur dengan spektrofotometer UV-Vis. Selain itu, juga dilakukan perbandingan efektivitas *biochar* murni dan *biochar*-Mn<sub>3</sub>O<sub>4</sub> sebagai adsorben zat warna kristal violet.

Hasil karakterisasi menunjukkan impregnasi Mn<sub>3</sub>O<sub>4</sub> terhadap *biochar* menyebabkan peningkatan kristalinitas dan kestabilan adsorben. Selain itu, didapatkan penambahan gugus fungsi berupa Mn-O-H dan permukaan *biochar* yang kaya oksigen. Adsorpsi zat warna kristal violet dengan *biochar* mencapai kondisi optimum pada pH larutan 6, massa adsorben 50 mg, waktu kontak 60 menit, dan konsentrasi awal zat warna 50 ppm. Adsorpsi dengan *biochar*-Mn<sub>3</sub>O<sub>4</sub> optimum pada pH larutan 8, massa adsorben 50 mg, waktu kontak 120 menit, dan konsentrasi awal zat warna 150 ppm. Proses adsorpsi zat warna kristal violet dengan kedua adsorben tersebut mengikuti kinetika orde dua semu dengan nilai konstanta laju sebesar  $3,3 \times 10^{-2} \text{ g mg}^{-1} \text{ menit}^{-1}$  dan  $1,2 \times 10^{-1} \text{ g mg}^{-1} \text{ menit}^{-1}$ . Model isoterm yang diikuti adalah Langmuir dengan nilai energi adsorpsi masing-masing 24,12 kJ mol<sup>-1</sup> dan 25,01 kJ mol<sup>-1</sup>, sehingga adsorpsi terjadi secara kimia. Impregnasi Mn<sub>3</sub>O<sub>4</sub> ke dalam *biochar* memberikan peningkatan kapasitas adsorpsi dari 344,40 mg g<sup>-1</sup> menjadi 598,97 mg g<sup>-1</sup> pada konsentrasi zat warna violet 1000 ppm.

Kata kunci: adsorpsi, *biochar*, kristal violet, kulit singkong, trimangan tetraoksida

## **Mn<sub>3</sub>O<sub>4</sub>-IMPREGNATED CASSAVA PEEL *BIOCHAR* FOR CRYSTAL VIOLET DYE ADSORPTION**

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### **ABSTRACT**

The use of *biochar* impregnated with Mn<sub>3</sub>O<sub>4</sub> as an adsorbent for crystal violet dye has been conducted. The study consisted of cassava peel *biochar* synthesis, *biochar* impregnation with Mn<sub>3</sub>O<sub>4</sub>, adsorbent characterization using XRD, FTIR, SAA, SEM-EDX instruments, and followed by crystal violet adsorption study with batch method. Parameters affecting adsorption performance such as solution pH, mass of adsorbent, interaction time, and initial adsorbate concentration were studied to determine the optimum conditions. The concentration of crystal violet dye before and after adsorption was measured by UV-Vis spectrophotometer. In addition, a comparison of pure *biochar* and Mn<sub>3</sub>O<sub>4</sub>-impregnated *biochar* in their effectiveness as adsorbents was also conducted.

The characterization results showed that the impregnation of Mn<sub>3</sub>O<sub>4</sub> to *biochar* caused an increase in crystallinity and stability of the adsorbent. In addition, new functional groups in the form of Mn-O-H and oxygen-rich *biochar* surface were obtained. Adsorption of crystal dye with *biochar* reached optimum conditions at pH 6, 50 mg adsorbent mass, 60 minutes contact time, and 50 ppm initial dye concentration. Adsorption with Mn<sub>3</sub>O<sub>4</sub>-impregnated *biochar* was optimum at pH 8, 50 mg adsorbent mass, 120 minutes contact time, and 150 ppm initial dye concentration. The adsorption process of crystal violet dye with both adsorbents followed pseudo second-order kinetics with rate constant values of  $3.3 \times 10^{-2} \text{ g mg}^{-1} \text{ min}^{-1}$  and  $1.72 \times 10^{-1} \text{ g mg}^{-1} \text{ min}^{-1}$ . The followed isotherm model was Langmuir with adsorption energy values of 24.12 kJ mol<sup>-1</sup> and 25.01 kJ mol<sup>-1</sup>, respectively, thus proving that adsorption occurred by chemisorption. The impregnation of Mn<sub>3</sub>O<sub>4</sub> into *biochar* increased the adsorption capacity from 344.40 mg/g to 598.97 mg/g at a violet dye concentration of 1000 ppm.

Keyword: adsorption, *biochar*, cassava peel, crystal violet, trimangan tetraoxide