



## ADSORPTION OF CONGO RED DYE USING KENAF CORE

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### Abstract

*Kenaf core is waste from the kenaf plant at fiber process. The utilization is still minimal, while the number increases due to the increasing number of fiber processes from kenaf plants to become rope or raw materials in the textile industry. However, the textile industry also produces dye waste which is harmful to the environment. Therefore, this study aims to utilize kenaf core as an adsorbent for the congo red dye. The adsorption of the congo red dye conduct by 2% kenaf core in 100 ml congo red solution in a shaker incubator. The initial concentration of congo red was varied 25, 50, and 75 ppm. The process adsorption was 15, 30, 45, 60, and 120 minutes. The research showed that kenaf core could decrease dye concentration up to 2 ppm, with decolorization reaching 96%. This study proves that kenaf core potential to be used as a dye adsorbent.*

*Keyword: adsorption, decolorization, congo red, dye, kenaf core,*

### Abstrak

*Core kenaf adalah limbah dari tanaman kenaf pada proses penyeratan. Penggunaannya masih sangat sedikit, sedangkan jumlahnya semakin bertambah seiring dengan semakin meningkatnya proses penyeratan kenaf untuk menjadi bahan rami dan bahan baku pada industry tekstil. Selain itu, industry tekstil juga mengeluarkan limbah cair zat warna yang dapat merusak lingkungan. Oleh karena itu, pada penelitian ini bertujuan untuk menggunakan core kenaf sebagai adsorben zat warna congo red. Proses adsorpsi zat warna congo red dilakukan menggunakan 2% core kenaf dalam 100 ml larutan zat warna pada incubator bergoyang. Konsentrasi awal zat warna congo red yang digunakan bervariasi 25, 50, dan 75 ppm. Proses adsorpsi berlangsung selama 15, 30, 45, 60, dan 120 menit. Hasil penelitian menunjukkan core kenaf dalam menurunkan konsentrasi congo red hingga 2 ppm dengan dekolourisasi mencapai 96%. Penelitian ini membuktikan core kenaf dapat digunakan sebagai adsorbent zat warna.*

*Kata kunci : adsorpsi, core kenaf, dekolourisasi, merah kongo, zat warna*

### INTRODUCTION

Synthetic textile dyes that are commonly used are direct dyes. The direct dye is water-soluble to be used in dyeing cellulose fibers such as cotton, rayon, and hemp. Direct dyes are relatively inexpensive and easy to use. Direct dyes are textile dyes

with a composition of 87% azo without metal, 5% azo metal complex, 5% stilbene, 1% oxazine, and 1% other substances [1]. Textile dyes are generally made from azo compounds and their derivatives. Based on the chemical structure, azo dyes occupy the most widely used dyes in the industry. Azo



dyes substances are commonly used in dyeing fabrics because azo dyes can be firmly bonded to fabrics, did not fade quickly, and good in coloring.

Congo red is one of the reactive dyes of azo compounds, primarily used in the textile industry. Congo red is soluble in water and difficult to degrade. The presence of Congo red dye in the aquatic environment can be harmful to various organisms. Congo red has moderate toxicity, and if it accumulates in the human body can damage the liver, kidney, and nerve [2]. It is important to treat the textile wastewater, especially congo red dyes, to prevent its adverse effect and reduce environmental pollution.

The adsorption process is an effective method for removing certain substances from industrial waste. Some of the advantages of the adsorption process were that the process does not leave sludge and perfectly absorbs the substances that want to be separated. The adsorption process also requires a smaller processing area than biological treatment, did not contain toxic chemicals, and had the excellent ability to remove organic contaminants. The adsorption process has many advantages, such as easier process, high effectiveness and efficiency of removal, and did not provide side effects in toxic substances. Several studies have been carried

out to reduce congo red waste, including by using rice bran [3], chitosan [4], graphite [5], banana inflorescence [6], and others.

Kenaf plant (*Hibiscus cannabinus L.*) has good adaptability to climate and soil. Kenaf is a warm-season annual fiber crop closely related to cotton. The kenaf plant is used to produce fiber. In the fiber separation process, kenaf core was produced. Kenaf plants can be used to adsorb laundry wastewater [7, 8]. In this paper, we investigate the congo red dye adsorption process using kenaf cores. We will also discuss the effects of concentration and processing time.

## MATERIAL AND METHODS

The kenaf cores used in this research came from kenaf plant processing in Malang. Kenaf cores were dried in the oven at 50 C until dry, then reduce the size with a grinder until 16 mesh in size. In this research, 2 grams of kenaf cores were put into 100 ml of congo red dye solution in a 250 ml Erlenmeyer flask. The variation in the initial concentration of the congo red dye was 25 ppm, 50 ppm, and 75 ppm. The adsorption process is carried out in batches. The adsorption process was varied for 15 minutes, 30 minutes, 45 minutes, 60 minutes, and 120 minutes. The adsorption process was carried



out at a room temperature of 27 C at 200 rpm agitation speed.

The sample after the process was filtered to separate the kenaf cores from the solution. The solution then measured the concentration by UV-vis spectrophotometer (Hitachi) at a wavelength of 500 nm. All treatments were done in duplicate.

Percentage of decolorization of congo red was calculated with the equation

$$Decolorization = \frac{C_o - C_i}{C_o} \times 100\%$$

Co: The initial concentration of congo red

Ci: The final concentration of congo red

## RESULT AND DISCUSSION

### Effect of adsorption time of congo red

Congo red has the molecular formula  $C_{32}H_{22}N_6Na_2O_6S_2$ . The IUPAC name of congo red is sodium benzidindiazo-bis-1-naphthylamine-4-sulfonate. This compound has a molecular weight of 696.67 g / mol [9]. In water, congo red forms red colloids. Congo red tends to form aggregates in organic and water solutions and gives varying sizes and shapes [10]. Congo red is widely

used in the cellulose industry, such as the cotton fabric and paper industries. Congo red can cause allergies such as anaphylactic shock and even cause cancer.

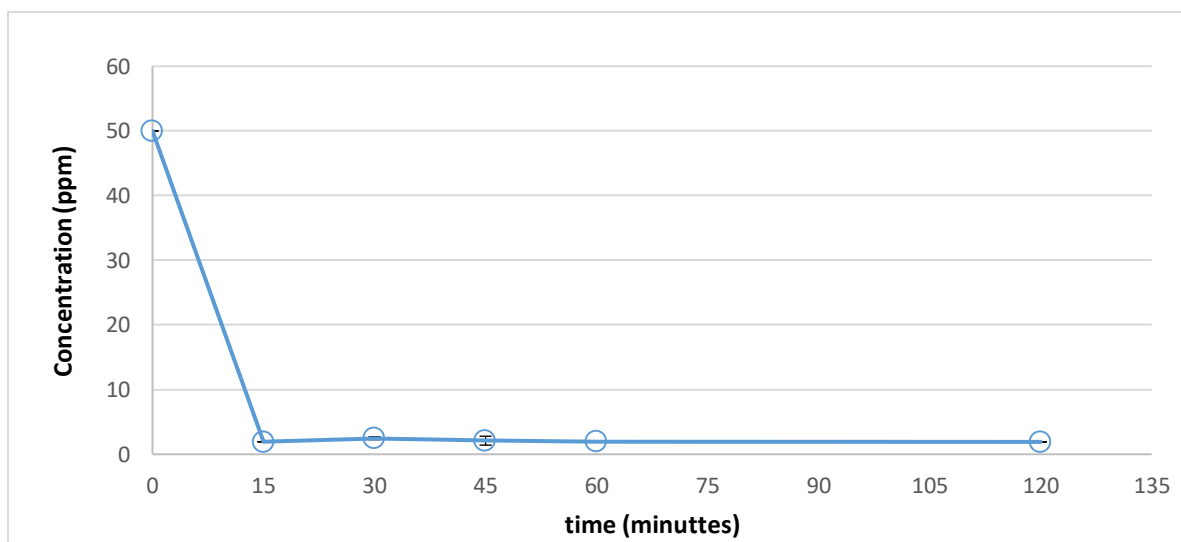
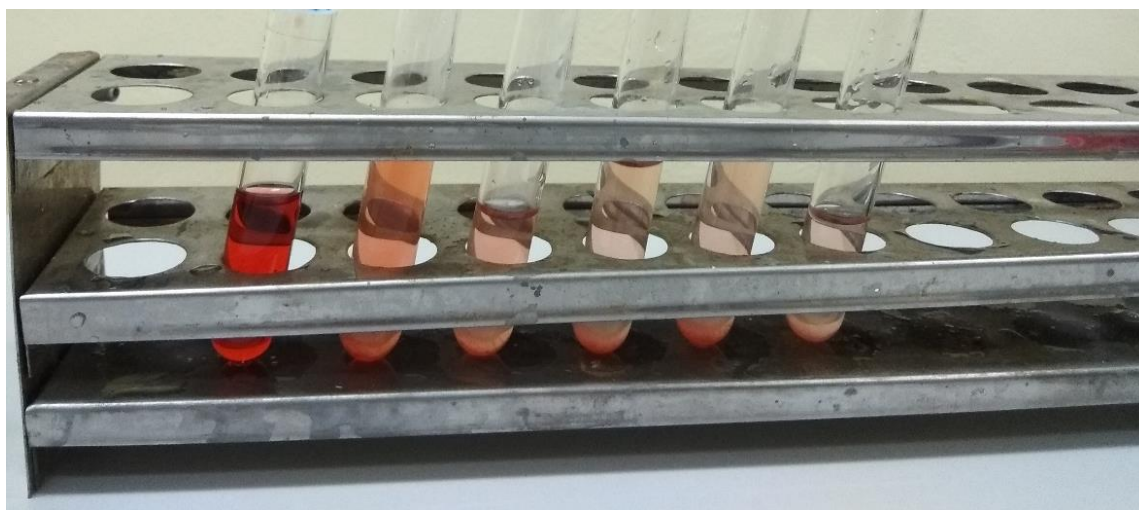
Adsorption is a series of processes for accumulating a substance (adsorbate) on the surface of another substance (adsorbent). This process can occur in several phases: liquid-liquid, gas-liquid, gas-solid, or liquid-solid [11]. Adsorption of congo red on the kenaf core was one type of liquid-solid adsorption. Figure 1a shows the congo red adsorption process using kenaf cores at various contact times. The concentration of congo red decreased with increasing processing time (figure 1b). This is due to the increasing number of congo red dyes adsorbed by the kenaf core. It can be seen that in the first 15 minutes, the concentration of congo red decreased to 1.92 ppm after adsorption using kenaf core from the initial concentration of 50 ppm. The concentration increased slightly again at 30 minutes; this is probably due to the desorption congo red from kenaf cores. However, it tends to be constant again even though the processing time is prolonged until it reaches 120 minutes. This is because the equilibrium concentration of congo red in the kenaf core has been achieved. The kenaf core can adsorb congo red quite well; this is probably due to



the absorption of congo red in the pores of the kenaf core.

The results showed that the decolorization of congo red at the first 15 minutes was quite good, achieved 96.14%. Prolonging the adsorption time until 30, 45, 60, and 120 minutes did not show a

significant decolorization value. This result could be concluded that the optimum time of this adsorption process was 15 minutes. The adsorption time of congo red on various adsorbents was in the range of 15-45 minutes. The results of this study are in line with the research of Herawati et al., which used banana inflorescence as an adsorbent [6].



**Figure 1.** (a) Photograph after adsorption, (b) Adsorption of congo red 50 ppm in variation time

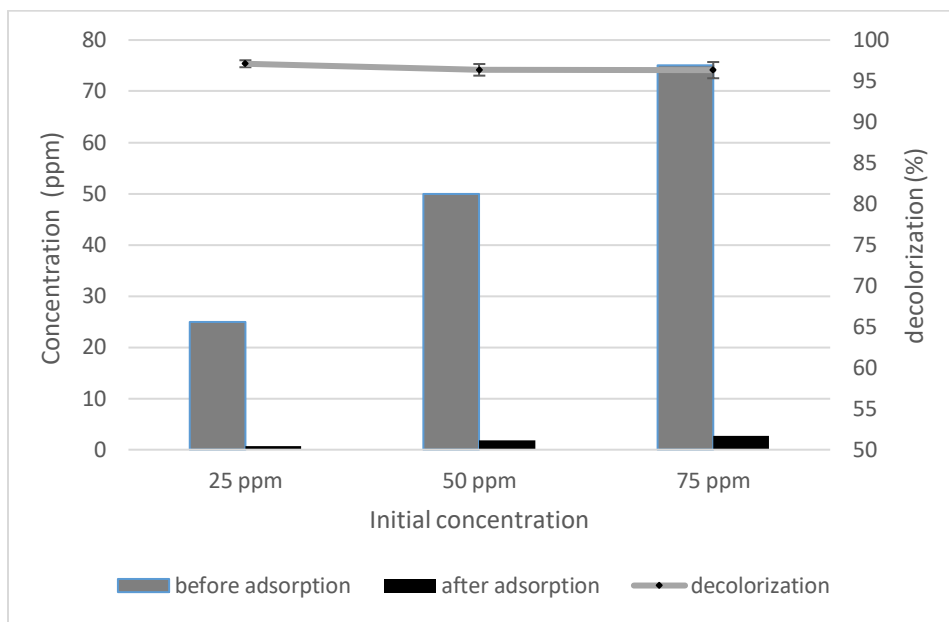


### **Effect initial concentration on congo red adsorption**

The adsorption process has been carried out in variation of adsorption time. The process resulted that 15 minutes was the optimum adsorption time for congo red. The effect of initial concentration on the adsorption of the congo red dye was carried out at the optimum time. The results were shown in Figure 2. Even in the variation of initial concentration, the kenaf core was capable of adsorbing the congo red dye. Figure 2 showed that the concentration of congo red after the adsorption process for 15 minutes had decreased significantly. The final concentration after adsorption has reduced until it reaches a concentration of 0.7 - 2.7 ppm. Increasing the initial concentration of the congo red caused increasing the final

concentration. However, it can be seen that this final concentration was smaller than five ppm.

Figure 2 shows the decolorization of congo red at 15 minutes of contact time. The kenaf core capable of reducing the concentration of congo red. The higher initial concentration congo red gave the lower decolorization, but the difference was no significant. This phenomenon happens because, in the higher congo red concentration, more dye in the solution must be absorbed by congo red, while kenaf core pores are already limited, so it cannot absorb the dye anymore. Decolorization of congo red from initial concentration 25 ppm at 15 minutes was achieved 97.10%. The results of this study were higher than the adsorption using rice husks [12].



**Figure 2.** Decolorization and concentration of congo red after adsorption

## CONCLUSIONS

Kenaf core can be used for the adsorption of Congo red dyes. The adsorption ability of the kenaf core was investigated by the variation of time adsorption and the initial concentration of Congo red dye. The optimum time process for kenaf core adsorption against the Congo red dye was 15 minutes. Decolorization of Congo red by 2% kenaf cores reached 96% at an initial concentration of 75 ppm. Kenaf core was potentially used as an adsorbent in the treatment of dye wastewater from the textile industry.

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## REFERENCES

- [1] D. Karyana, "Pengantar Kimia Zat Warna," *Bandung: Sekolah Tinggi Tekstil*, 2010.
- [2] I. G. A. A. Saraswati, N. P. Diantariani, and P. Suarya, "Fotodegradasi zat warna tekstil Congo red dengan fotokatalis ZnO-arang aktif dan sinar ultraviolet (UV)," *Jurnal Kimia (Journal of Chemistry)*, 2015.
- [3] R. Herlina, M. Masri, and S. Sudding, "Studi Adsorpsi Dedak Padi terhadap Zat Warna Congo Red di Kabupaten Wajo," *Chemica: Jurnal Ilmiah Kimia dan Pendidikan Kimia*, vol. 18, no. 1, pp. 16-25, 2017.



- [4] T. Prameswari, "Sintesis Membran Kitosan-Silika Abu Sekam Padi Untuk Dekolorisasi Zat Warna Congo Red," Universitas Negeri Semarang, 2013.
- [5] R. Vinsiah, R. Mohadi, and A. Lesbani, "Performance of Graphite for Congo Red and Direct Orange Adsorption," *Indonesian Journal of Environmental Management and Sustainability*, vol. 4, no. 4, pp. 125-132, 2020.
- [6] D. Herawati, S. D. Santoso, and I. Amalina, "Kondisi Optimum Adsorpsi-fluidisasi Zat Warna Limbah Tekstil Menggunakan Adsorben Jantung Pisang," *Jurnal SainHealth*, vol. 2, no. 1, pp. 1-7, 2018.
- [7] S. Mangkoedihardjo and D. Argita, "Fitoremediasi tanah inceptisols tercemar limbah laundry dengan tanaman kenaf (*hibiscus cannabinus* L.)," *Jurnal purifikasi*, vol. 16, no. 1, pp. 33-43, 2016.
- [8] L. HAKIM, "PENGOLAHAN LIMBAH LAUNDRY DENGAN MENGGUNAKAN TANAMAN KENAF (*Hibiscus cannabinus* L.)," Institut Teknologi Sepuluh Nopember, 2016.
- [9] R. Khurana, V. N. Uversky, L. Nielsen, and A. L. Fink, "Is Congo red an amyloid-specific dye?," *Journal of Biological Chemistry*, vol. 276, no. 25, pp. 22715-22721, 2001.
- [10] T. Tapalad, A. Neramittagapong, S. Neramittagapong, and M. Boonmee, "Degradation of Congo red dye by ozonation," *Chiang Mai J Sci*, vol. 35, no. 1, pp. 63-8, 2008.
- [11] F. Çeçen and Ö. Aktas, *Activated carbon for water and wastewater treatment: Integration of adsorption and biological treatment*. John Wiley & Sons, 2011.
- [12] T. Setyaningtyas and U. Sulaeman, "Pengaruh pH larutan dan ukuran partikel abu sekam padi terhadap penurunan kadar Congo Red," *Molekul*, vol. 2, no. 1, pp. 7-12, 2007.