Utilization of Pectin from Durian (*Durio zibethinus*) Seeds in Adsorption of Methyl Violet Dye

Agnesya Agustina[1,], Rahmawati Nirmala Sari[2], Kuntari[3*].

[1,2,3] Chemical Analyst Department, Faculty of Mathematic and Science, Islamic University of Indonesia
Kampus Terpadu UII, Jl. Kaliurang Km 14, Sleman, Yogyakarta, *email: 162310401@uii.ac.id

Abstract

A research about adsorption of methyl violet by using pectin from durian seed has been conducted. This research aims to study the ability of pectin in methyl violet adsorption. Adsorption parameters are contact time and pH condition were examined in the batch adsorption processes. Pectin characterization was performed by FTIR spectrometry. Methyl violet concentration was determined quantitively by UV-Vis spectrophotometer. FTIR results show that the samples showed the typical fingerprint in IR spectrogram. The adsorption result on 25 mL of 100 mg/L methyl violet solution achieved 96.22% of adsorption when the pH condition is 3; contact time 21 minutes and pectin 0.25 g.

Keywords: pectin, adsorption, durian seed, methyl violet

Introduction

Durian is one of leading commodities of Indonesian farmers. Global production of approximately 883,969 tonnes in 2011 (BPS, 2011). The durian rind and seed accounts about four-fifths of the total fruit mass and it is usually discarded. Durian seed is recognized as a source of starch. Starch content in durian seeds reaches 42.1%. Starch or amylum is composed of two kinds of carbohydrates, amylose and amylopectin in different compositions which are 10-20% amylose and 80-90% amylopectin. Amylopectin consists of chains of amylose α (1-4) linked to form a branch with a glycoside α-(1-6) bond (Abu Bakr et al., 2013). Pectin is a group of heterosaccharide polymers obtained from cellular plant cell walls. Commercial pectins are mainly produced by extraction with diluted mineral acid from citrus peels and apple pomace, both of which are waste materials from the juice industries. The structure of pectin as show in Figure. 1.

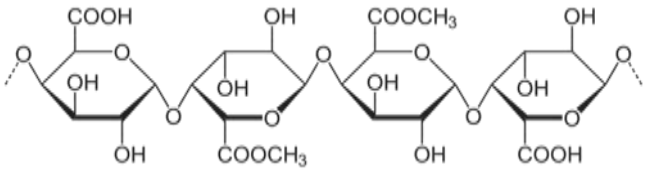

Fig. 1. Structure of pectin

Previous research have shown that pectin can be used as an adsorbent for the removal of heavy metals and methyl dye from aqueous solution (Annadurai, 2001). The one of methyl dye is methyl violet. IUPAC name of methyl violet is 4-[(4-dimethylaminophenyl) phenyl-methyl]-N. Methyl violet dye included in the class of cationic dye with the chemical formula $C_{24}H_{28}N_3Cl$ and molecular weight of 393.96 g/mol. Methyl violet soluble in water and ethanol. The structure of methyl violet is shown in Figure 2.

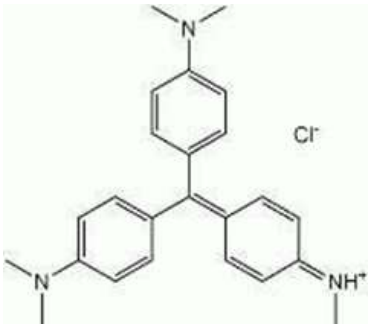

Fig. 2. Structure of methyl violet

Methyl violet has toxic properties that can cause gene mutations and waste problems in the aquatic environment. Dyestuff waste can reduce the intensity of light entering the waters so that photosynthesis process is disturbed and increase the value of BOD and COD. Therefore, the objective of this research is to remove methyl violet dye from the solutions by using pectin from durian seeds.

Materials and Method

Pectins were extracted from durian seeds under reflux for 2 hours at 90 ^{O}C, using a solid-liquid ratio of 1:3 (w/v). After pectin extraction, the mixture was filtered allowed to cool to room temperature (about 28 ^{O}C). The extracts were precipitated with ethanol 96%, using a solid-liquid ratio of 1:1 for 20 hours. In the next step, the precipitated was collected and dried in a hot air oven at 50 ^{O}C for 7 days. The pectin obtained from this process was named Durian Seed Pectin (DSP). Fourier transform infrared (FTIR) spectra of DSP was recorded by a device called Perkin

Elmer FTIR spectrometer (Nicolet Avatar 360 IR) [1]. Furthermore, FTIR measurement was obtained over the range of 4000- 400 cm^{-1}.

Adsorption experiments were carried out with 100 mL Erlenmeyer flask. Methyl violet dye was dissolved separately in 250 mL of deionized water to prepare stock solutions 100 mg/L, which were kept in dark coloured glass bottles. For batch study, aqueous solutions were prepared from stock solutions in deionized water. A 100 mL of dye solution of known initial concentration was contact with a required dose of pectin at a constant stirring. After a specified stirring time period, the reaction mixture was filtered and pH of filtrate was measured. Then the dye concentration in the filtrate was determined by measuring absorbance at the wavelength of maximum absorption (578 nm for methyl violet) using a Spectrophotometer model Thermo Scientific Genesys 20. The pH of solution was adjusted by adding either HCl or NaOH solution. The percentage removal of the dye were calculate by the following relationships:

$$\text{Percentage removal} = 100\ (C_i - C_f) / C_i \quad (1)$$

Where C_i and C_f are the initial and final concentretions (mg/L) of the dye, respectively.

Results and Discussion

Characterization of adsorbent

FT-IR analysis was made to evaluate characteristics of pectin. The FTIR spectrum of DSP are illustrated in Figure 3. The wavenumbers of FTIR spectra related to DSP and commercial pectin (citrus pectin) were compared together in Table 1.

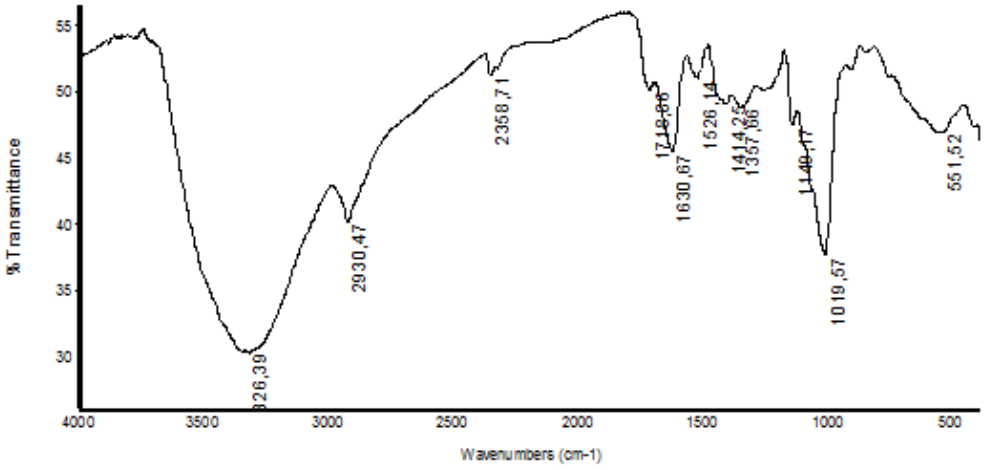

Fig. 3. Fourier transform infrared spectra of DSP

The peaks at around 3282 and 2920-2940 cm^{-1}, were due to the stretching vibrations of hydroxyl groups (OH) and C-H of CH, CH_2 and CH_3 groups, respectively (Santos et al., 2013). The bond at around 1742 cm^{-1} was attributed to C=O stretching vibration of the carboxylic acid methyl ester, while the bonds at about 1656 and 1427 cm^{-1} were attributed to C=O stretching vibration of free carboxyl groups. The peaks between 1000 and 1200 cm^{-1} showed that the samples contained pyranose and furanose (Wang et al., 2015). In general, all the bonds between 800 and 1200 cm^{-1} are referred to as the "finger print" area that is unique to a compound and thus its explanation can be a difficult issue (Chen, et al., 2014).

Table 1. Assignments of FT-IR wavenumbers in the range 4000 - 400 cm^{-1} of DSP and commercial pectin

FT –IR wavenumber (cm^{-1})		Assignments
DSP	Commercial Pectin	
3326	3389	O-H
2930	2940	C-H
1718	1753	C=O from methylesterfied carboxyl groups
1630 and 1414	1630 and 1441	C=O from free carboxyl group
1019 -1140	1000-1200	Finger print

Effect of contact time

The relation between removal of dyes and contact time were studied to see the rate of dye adsorption. Figure 4 depicts the effect of contact time on the adsorption of methyl violet with DSP.

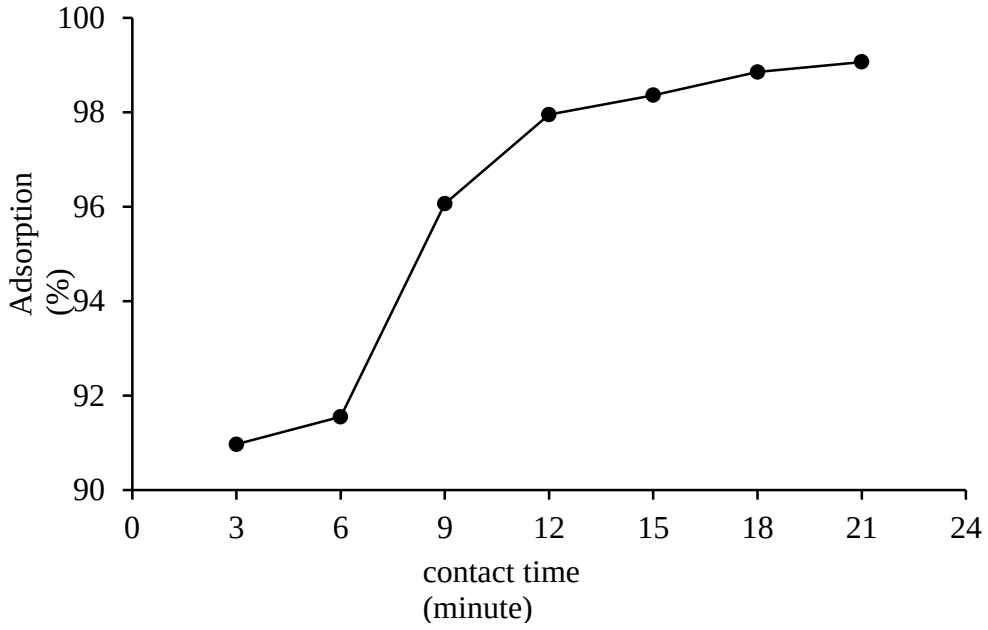

Fig. 4. Effect of contact time on the adsorption of methyl violet by DSP

Figure 4 show that the adsorption of methyl violet solution reached equilibrium within 21 minute. However, the adsorption of methyl violet gently increased in the first 6 minute. The result confirmed that the short time is required to attain the adsorption equilibrium.

Effect of initial solution pH

The effect of initial pH on the adsorption of methyl violet by DSP was also studied, and the results are shown in Figure 5. The effect of pH solution on adsorption of methyl violet were determined at 100 mg/L of dyes over a pH range 3-9. The effect of initial pH on adsorption of methyl violet was slightly decreased with increasing the solution pH.

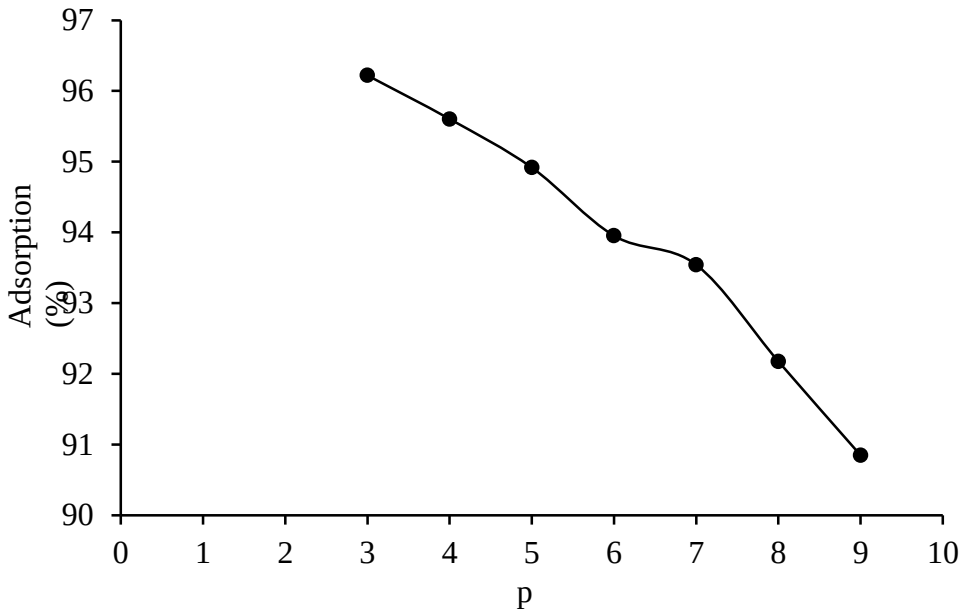

Fig. 5. Effect of initial pH on the adsorption of methyl violet by DSP

In fact the highest adsorption of methyl violet at low pH was affected by de-polymerization of pectin. De-polymerization is the breaking process of molecular chains that lead to structural modification. Therefore, methyl violet more likely to be adsorbed by DSP.

Conclusion

Durian seed can be utilized to be pectin, then the resulting pectin can be used as adsorbent to adsorp methyl violet dyestuff. In this experiment, variations of contact time and optimum pH were performed. The results obtained with the pectin mass of 0.25 gram can adsorp methyl violet at initial concentration of 100 mg/L and optimum pH solution 3 within 21 minutes with the adsorption percentage obtained 96.22 %.

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