

PAPER • OPEN ACCESS

Preface

To cite this article: 2019 *J.Phys.:Conf.Ser.* **1282** 012029

View the [article online](#) for updates and enhancements

You may also like

- [Bacterial Cellulose Derived Carbon Nanofibers As High Capacity Anode for Lithium-Ion-Batteries](#)
Illa Mani Pujitha, Mudrika Khandelwal and Chandra Sherkar Sharma
- [New Analytical Methode for Cellulose Acetate Electrophoresis Using Terahertz Imaging](#)
Hong Bing Zhang, Kazutaka Mitobe, Masafumi Suzuki et al.
- [Purification of water from heavy metal ions by a dynamic membrane with a surface layer of cellulose acetate](#)
D D Fazuallin and R D Fazylova



The banner features the ECS logo on the left, followed by the text 'The Electrochemical Society' and 'Advancing solid state & electrochemical science & technology'. Below this is '243rd Meeting with SOFC-XVIII' and 'Boston, MA • May 28 – June 2, 2023'. A blue button with white text says 'Learn More & Register'. On the right, a woman in a black top and light blue pants stands at a podium with a laptop, smiling. The background is a blurred indoor setting.

ECS The Electrochemical Society
Advancing solid state & electrochemical science & technology

243rd Meeting with SOFC-XVIII

Boston, MA • May 28 – June 2, 2023

Accelerate scientific discovery!

Learn More & Register

PROCEEDINGS

SICBAS 2018

THE 1ST SRIWIJAYA INTERNATIONAL CONFERENCE ON BASIC AND APPLIED SCIENCES

“SCIENCES FOR SUSTAINABLE DEVELOPMENT”

**Horison Ultima Hotel Palembang, South Sumatra - Indonesia
November 6-7st, 2018**



PREFACE

The 1st SRIWIJAYA INTERNATIONAL CONFERENCE ON BASIC AND APPLIED SCIENCES (SICBAS 2018) with the theme "Sciences for Sustainable Development". The conference held on November 6-7th, 2018 at the Horison Ultima Hotel Palembang, South Sumatra, Indonesia. This event is launched so as to provide a chance and venue for researchers to come together for research presentations and dissemination's. The conference is biennial important event to publish communicate they research results in basic and applied sciences.

Hopefully this international proceeding will be able to encourage students, teachers, lecturers, practitioners, researchers, and higher education community in developing scientific and academic atmosphere in Indonesia.

On behalf of the committee of the SICBAS 2018 we would like to thank to all parties for their participation in supporting this publication and we would like to invite all of researchers and scientists to take a part in the 2nd SICBAS which will be held in 2020 by The Faculty of Mathematics and Natural Sciences, Sriwijaya University.

Palembang, November 7th 2018

Chairman,

Dr. Fiber Monado

ORGANIZING COMMITTEE

Advisory Board

Prof. Anis Saggaf (Sriwijaya University, Indonesia)

Prof. Zainuddin Nawawi (Sriwijaya University, Indonesia)

Prof. Khairurrijal (ITB, Indonesia)

Associate Prof. Minetaka Sugiyama (Osaka University, Japan) Prof. Ibrahim Mohamed (University of Malaya, Malaysia) Prof. Mitra Djamal (ITB, Indonesia)

Scientific Committee

Prof. Iskhaq Iskandar (Sriwijaya University, Indonesia)

Prof. Kamaruzzaman Seman (USIM, Malaysia)

Prof. Irawati (ITB, Indonesia)

Eko Siswanto, Ph.D. (JAMSTEC, Japan)

Dr. Haris Gunawan (Peatland Restoration Agency, Indonesia)

Dr. Hagi Yulia Sugeha (LIPI, Indonesia)

Dr. Rashid Mehmood (Ottawa Hospital Research Institute, Canada)

Prof. Aldes Lesbani (Sriwijaya University, Indonesia)

Local Committee (Sriwijaya University, Indonesia)

Chairman : Dr. Fiber Monado

Vice Chairman : Dr. Frinsyah Virgo

Secretary : Dr. Bambang Suprihatin

Treasurer : Dr. rer. nat. Indra Yustian

Members: – Dr. Rozirwan

– Dony Setiawan, M.Si

– Dr. Poeji Loekitowati

– Dr. Eliza

– Dr. Arum Setiawan

– Dr. Siti Sailah, M.Si

– Hermansyah, Ph.D

– Anna Ida Sunaryo P, S.Pi., M.Si

– Dr.rer.nat. Mardiyanto, M.Si

– Dr. Fitri Maya Puspita, M.Sc

– Dr.rer.nat. Risfidian Mohadi

– Dr. Idha Royani

– Dr. T. Zia Ulqodry

– Dr. Akhmad Aminuddin Bama, M.Si

– Zainal Fanani, S.Si., M.Si

– Sutopo, S.Si., M.Si

– Alfensi Faruk, M.Sc

– Akmal Johan, M.Si

– Andy Agussalim, M.Sc

– M. Fuad, M.Kom

– Sisca Oktarina, M.Sc

– Miyanto, S.APAnna Safitri, MSc., PhD

Editorial Team

Editor in Chief : Dr.rer.nat Risfidian Mohadi, M.Si

Deputy of chief editor : Dr. Idha Royani

Reviewer Board Members

1. Prof. Dr. Iskhaq Iskandar Universitas Sriwijaya
2. Prof. Dr. Aldes Lesbani Universitas Sriwijaya
3. Dr. Adhitya Ronnie Effendie Universitas Gajah Mada
4. Dr. Arum Setiawan Universitas Sriwijaya
5. Dr. Azhar Kholiq Affandi Universitas Sriwijaya
6. Dr. Bambang Suprihatin Universitas Sriwijaya
7. Dr. Eliza Universitas Sriwijaya
8. Dr. Fauziah Universitas Sriwijaya
9. Dr. Fiber Monado Universitas Sriwijaya
10. Dr. Fitri Maya Puspita Universitas Sriwijaya
11. Dr. Frinsyah Virgo Universitas Sriwijaya
12. Dr. Harry Wijayanti Universitas Sriwijaya
13. Dr. Heri Satria Universitas Lampung
14. Dr. Hermansyah Universitas Sriwijaya
15. Dr. Idha Royani Universitas Sriwijaya
16. Dr. Masturi Universitas Negeri Semarang
17. Dr. Menik Ariani Universitas Sriwijaya
18. Dr. Poeji Lukitowati Universitas Sriwijaya
19. Dr. Rahadi Wirawan Universitas Mataram
20. Dr. rer.nat Mardiyanto Universitas Sriwijaya
21. Dr. rer.nat. Maya Shovitri Institut Teknologi Sepuluh November
22. Dr. Siti Sailah Universitas Sriwijaya
23. Dr. Yulianto Suteja Universitas Udayana
24. Dr. Zia Ulqodri Universitas Sriwijaya
25. Dr.rer.nat Risfidian Mohadi Universitas Sriwijaya
26. Dr. A. Aminuddin Bama Universitas Sriwijaya
27. Anna Ida Sunaryo, M.Si Universitas Sriwijaya







Table of contents

Volume 1282

2019

· [Previous issue](#) [Next issue](#) ·

Sriwijaya International Conference on Basic and Applied Science 6–7 November 2018, Palembang, Indonesia

Accepted papers received: 26 June 2019

Published online: 14 August 2019

[Open all abstracts](#)

Preface

OPEN ACCESS 011001

[Preface](#)

· [Open abstract](#)  [View article](#)  [PDF](#)

OPEN ACCESS 011002

[Peer review statement](#)

· [Open abstract](#)  [View article](#)  [PDF](#)

Chemistry

Optimization production and distribution using production routing problem with perishable inventory (PRPPI) models 012001

Novi Rustiana Dewi, Eka Susanti, Eddy Roflin, Tiara Bella Octalia and Rika Novita

· [Open abstract](#)  [View article](#)  [PDF](#)

OPEN ACCESS 012002

On Selected Issues off Boolean Fumcation Application In Symmeriv Ker Cryptpgraphy Against Side Channel Attacks

Kamarruzzaman Seman, Mohammad Fahim Roslan, Azni Haslizan Ab Hailm And M Nor Azizi Syam Mohd Sayuti

· [Open abstract](#) [View article](#) [PDF](#)

The effect of interactive demonstration method on heat energy learning
Ria Triayomi

012003

· [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Improved cloud computing model of internet pricing schemes based on Cobb-Douglas utility function

012004

Indrawati, Fitri Maya Puspita, Evi Yuliza, Oki Dwipurwani, Yossy Eka Putri and Affriyanti

· [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Naive Bayes classifier for infant weight prediction of hypertension mother
Anita Desiani, Rifkie Primartha, Muhammad Arhami and Osvari Orsalan

012005

· [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

012079

Modification of cellulose with acetic acid to removal of methylene blue dye
Poedji Loekitowati Hariani, Fahma Riyanti and Asri Kurniaty

· [Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Identification of surface macro debris in river flow and estuary of Musi River, South Sumatera Province, Indonesia

0120106

R Maherlsa, A IS Purwiyanto, F Agustriani, W AE Putri, Fauziyah and Ferdiansyah

· [Open abstract](#) [View article](#) [PDF](#)

0120107

OPEN ACCESS

A numerical study of mixing and sediment transport caused by tidal in the Bontang waters
N Alghifari, Y N Nasution and I Mandang

· [Open abstract](#) [View article](#) [PDF](#)

0120108

OPEN ACCESS

Providing biodiversity information to support sustainable development of Sugihan wetlands, South Sumatra

Arum Setiawan, Muhammad Iqbal, Doni Setiawan and Indra Yustian

· [Open abstract](#) [View article](#) [PDF](#)

Microplastic contamination

OPEN ACCESS

on *Anadara granosa* Linnaeus 1758 in Pangkal Babu mangrove forest area, Tanjung Jabung Barat district, Jambi
Syaidah Fitri and M P Patria

0120109

· [Open abstract](#)  [View article](#)  [PDF](#)

0120110

OPEN ACCESS

Propagation for conserving endangered taxol producing tree *Taxus sumatrana* through shoot cuttings technique
A Susilowati, H H Rachmat, C R Kholibrina, K S Hartini and H A Rambe

· [Open abstract](#)  [View article](#)  [PDF](#)

JOURNAL LINKS

[Journal home](#)

[Journal scope](#)

[Information for organizers](#)

[Information for authors](#)

[Contact us](#)

[Reprint services from Curran Associates](#)

PAPER • OPEN ACCESS

Modification of cellulose with acetic acid to removal of methylene blue dye

To cite this article: Poedji Loekitowati Hariani *et al* 2019 *J. Phys.: Conf. Ser.* **1282** 012079

View the [article online](#) for updates and enhancements.

Recent citations

- [Tailored higher performance silicone elastomer with nanofibrillated cellulose through acidic treatment](#)
Safarul Mustapha and Yoshito Andou



The banner features a decorative top border with a repeating pattern of red, white, and blue diagonal stripes. On the left, the ECS logo is displayed in green and blue, followed by the text 'The Electrochemical Society' and 'Advancing solid state & electrochemical science & technology'. In the center, the text '239th ECS Meeting with IMCS18' is written in a large, bold, dark blue font. Below this, 'DIGITAL MEETING • May 30-June 3, 2021' and 'Live events daily • Free to register' are listed in a smaller, dark blue font. On the right side, there is a graphic of a person's head with glowing blue neural connections and a laptop icon. A red button with white text 'Register now!' is positioned at the bottom right. A small logo with '18th' is visible in the upper right corner of the banner area.

ECS The Electrochemical Society
Advancing solid state & electrochemical science & technology

239th ECS Meeting with IMCS18

DIGITAL MEETING • May 30-June 3, 2021

Live events daily • Free to register

Register now!

Modification of cellulose with acetic acid to removal of methylene blue dye

Poedji Loekitowati Hariani¹, Fahma Riyanti, Asri Kurniaty

Department of Chemistry, Faculty Mathematics and Natural Sciences, Sriwijaya University

Email: ¹ puji_lukitowati@mipa.unsri.ac.id

Abstract. The study on cellulose modification with acetic acid to cellulose-acetate has been carried out. Cellulose is extracted from the kepok banana peel (*Musa paradisiaca* L.). Modified cellulose acetate was characterized by FTIR spectroscopy and SEM-EDS. Cellulose acetate to removal of methylene blue with adsorption parameter include initial concentration (10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 mg/L), pH solution (3, 4, 5, 6, 7, and 8) and contact time (15, 30, 45, 60, 75, and 90 minutes). The peak of FTIR cellulose acetate obtained by functional groups -OH, C-H, C=O, and C-O esters. The morphology of cellulose-acetate has a more homogeneous than cellulose. Adsorption of cellulose-acetate on methylene blue optimum at an initial concentration of 90 mg/L, pH of solution 6, and contact time of 30 minutes. The adsorption kinetics corresponds to pseudo-second order and adsorption equilibrium corresponds to Langmuir isotherms with adsorption capacity of 42.107 mg/g.

1. Introduction

The appearance of synthetic dyes in the environment has two effects including toxicology and esthetical [1]. Industries such as textile, paper, ceramics, plastics, leather, cosmetic, rubber, and paints produce wastewater containing dyes [1-2]. The presence of dyes on the surface water prevents light penetration and inhibits photosynthesis. Another impact, the ecosystem and biota life are disrupted [3]. Therefore, it is necessary to treat wastewater containing dyes before discharged into the environment.

Methylene blue is a cationic dye. The empirical formula for the methylene blue is $C_{37}H_{27}N_3Na_2O_9S_3$. The use of methylene blue has an impact on human health. The danger of methylene blue against the eyes can cause blind eyes, if inhaled it can cause difficulty breathing dyspnea, and chest discomfort. Other hazards, if ingested by methylene blue causes a burning sensation, nausea, vomiting, diarrhea, and gastritis [4]. Various methods can be used to removal dyes such as photocatalytic degradation [5], cation exchange [6], coagulation and flocculation [7], adsorption [1]. The adsorption method is one method that has the advantages of simple design, easy operation, non-toxicity, low cost and high adsorption capacity [8-9]. Adsorption using biological materials has the term biosorption. The excellence of biosorption is competitive, effective and inexpensive [1]. Many biomaterials are used to removal dyes from aquatic or wastewater, for examples of cellulose [10], chitosan [11], coconut shell activated carbon [9], walnut shell powder [12], sugar extracted from spent rice biomass [13]. In also, adsorption does not produce harmful substances [1].

Cellulose is a biopolymer that has the potential as biosorbent. Cellulose is polymer that is abundant in nature. Cellulose is a major component of plant fibers [14]. Cellulose has the potential for adsorption of dye. Cellulose extracted waste (banana dan orange peel) can be the removal of methyl orange,



rhodamine B, methylene blue, methyl violet, congo red, and amido black 10B from aqueous solution [10]. Cellulose modification can improve cellulose properties and increase adsorption capacity. Cellulose can be modified with a hydrophilic or hydrophobic group.

This study extracted cellulose from kepok banana peel and modified it with acetate which was used to removal methylene blue from aqueous. Kepok banana plant is one of the tropical plants have even distribution area at all regions of Indonesia. Banana included superior commodities that are easy to cultivate, short-lived, and can be harvested throughout the year.

2. Material and methods

2.1. Material

Methylene blue was obtained from Sigma Aldrich with case number 28983-56-4, sodium hydroxide, hydrochloric acid, glacial acetic acid, acetic anhydride and sulfuric acid from Merck, distilled water. Kepok banana peel from Palembang traditional market.

2.2. Synthesis of cellulose-acetate

Cellulose extraction from kepok banana skin according to the Hariani et al procedure [15]. About 100 g kepok banana peel dry with a size of 100 mesh soaked with ethanol/toluene (100:100) mL for 3 days. Then, the bleaching process using 250 mL NaOCl (6%), stirred for 3 hours by heating 80 °C. As a result of bleaching, 300 mL NaOH (4%) was added, stirred for 4 hours at 60 °C, filtered and washed with distillate water. Into the extract added of H₂O₂ (30%) 200 mL and NaOH (4%) 400 mL in a water bath for 1 hour at 85 °C, filtered. Added H₂O₂ (10%) 200 mL, stirred for 1 hour at 85 °C. Next, washed to neutral pH and dried at 40 °C for 24 hours.

A total of 4 g of cellulose was dissolved with 50 mL of glacial acetic acid. The solution was stirred for 1 hour at room temperature. 30 mL of acetic anhydride and 6 drops of sulfuric acid (98%) were mixed in an Erlenmeyer and maintained at 0 °C in a container containing ice. Then, added with cellulose solution. The mixture was stirred for 3 hours at 40 °C, added 50 mL of 60% glacial acetic acid by dropwise. The cellulose-acetate is filtered, futhermore washed with distilled water until the neutral pH. The product dried in an oven at 50 °C for 3 hours. The cellulose-acetate was identified using FTIR SHIMADZU 500 and SEM-EDS JEOL JSM 6510-LA.

2.3. Adsorption Procedure

Adsorption was carried out by the batch method. Effect of initial concentration by total of 50 mL of the methylene blue solution with varying concentrations (10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 mg/L) was added with a cellulose acetate 0.1 g. The mixture is stirred for 30 minutes and filtered. The adsorbent was separated from the solution and determined the remaining methylene blue using spectrophotometer UV-Vis mini-1240 SHIMADZU.

Effect of the pH solution in variations of pH 3, 4, 5, 6, 7, and 8 with the addition of HCl and NaOH, then added 0.1 g of cellulose acetate, stirred for 30 minutes then filtered. The adsorbent was separated from the solution and determined the remaining methylene blue using spectrophotometer. The effect of contact time for sorption of methylene blue by cellulose acetate was carried out with variations of contact time 15, 30, 45, 60, 75 and 90 minutes. The cellulose-acetate was separated from the solution and determined the remaining methylene blue using spectrophotometer. The amount of dye absorbed is calculated by the equation:

$$q_e = (C_0 - C_e) \frac{V}{M} \quad (1)$$

Where q_e = amount of dye (mg/g), C_0 and C_e = initial and equilibrium of dye concentration (mg/L), V = volume of dye solution (L) and M = mass of cellulose acetate (g).

2.4. Adsorption Isotherm

Adsorption isotherm using 2 models, namely Langmuir and Freundlich isotherm. The Langmuir isotherm has the opinion that adsorption occurs on the surface of the monolayer with identical active sites. The Langmuir equation is as follows:

$$\frac{1}{q_e} = \frac{1}{q_m} + \frac{1}{K_L q_m C_e} \quad (2)$$

Where q_m is adsorption capacity (mg/g), K_L is Langmuir constant (L/mg) related to affinity and free energy sorption.

The Freundlich isotherm describes a heterogeneous surface. The linear expression of the Freundlich isotherm is written:

$$\ln q_e = \ln K_F + \frac{1}{n} \ln C_e \quad (3)$$

where K_F and $1/n$ are related to the adsorption capacity and intensity of the system. This value is obtained from the plot of C_e versus $\ln q_e$ versus $\ln C_e$.

2.5. Adsorption Kinetic

Adsorption kinetics were studied using pseudo-first order and pseudo-second order. The pseudo-first order equation is as follows:

$$\ln(q_e - q_t) = \ln q_e - K_1 t \quad (4)$$

where q_t and q_e the amount of dye absorbed at the time (mg/g) and equilibrium. K_1 is a constant for pseudo-first order (min^{-1}) and t is time (min). The pseudo-second order equation is displayed :

$$\frac{t}{q_t} = \frac{1}{K_2 q_e^2} + \frac{t}{q_e} \quad (5)$$

Where K_2 is a constant that describes the reaction speed of pseudo-second order (g/mg min^{-1}).

3. Result and Discussion

3.1. Characterization of cellulose acetate

The cellulose extraction process uses NaOH to release lignin from cellulose. The bleaching process uses NaOCl to purify cellulose by decreasing color and another component [16]. Then the acetylation reaction uses acetic anhydride (acetylation agent), glacial acetic acid as a solvent and sulfuric acid as a catalyst. The cellulose modification with acetate cause changes in the number of hydroxyl groups and surface morphology that can affect the capacity adsorption of adsorbent.

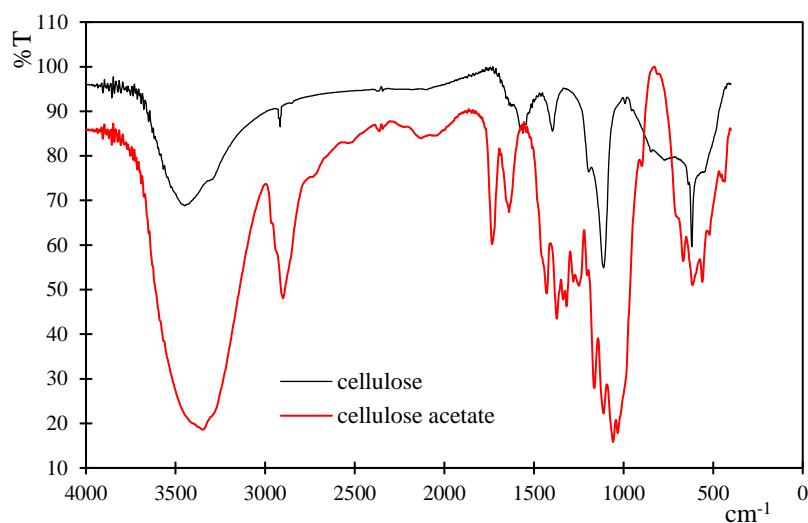


Figure 1. Spectra FTIR cellulose and cellulose acetate

Figure 1 shows spectra FTIR of cellulose and cellulose acetate. Analysis of functional groups using FTIR spectroscopy to obtain information about chemical changes after the acetylation process. Absorption at wave number 3354.0 cm^{-1} on cellulose and 3352.1 cm^{-1} in cellulose acetate which showed the presence of $-\text{OH}$ group by intermolecular and intramolecular [16]. The presence of a C-H and $-\text{CH}_2$ stretching in the wave number of 2916.2 cm^{-1} in cellulose and 2896.9 cm^{-1} in cellulose acetate. FTIR spectra of cellulose-acetate emerged two new absorption regions at wave number of 1733.9 cm^{-1} and 1244.0 cm^{-1} which showed the presence of $\text{C}=\text{O}$ and $\text{C}-\text{O}$ esters whereas in the FTIR spectra of cellulose did not have these functional groups. The success of syntheses was also identified by increasing the intensity at wave number 1373 cm^{-1} which showed C-H bending vibration and C-O stretching at 1186 cm^{-1} . The peak at 1051.9 cm^{-1} indicating C-O-C from pyranose ring, similar to the peak of cellulose (from rice husk) acetate obtained at wave number 1051 cm^{-1} [17]. Table 1 shows the wave number of cellulose and cellulose acetate.

Table 1. The wave number of cellulose and cellulose acetate

| Functional group | Wave number (cm^{-1}) | Wave number (cm^{-1}) | |
|------------------|----------------------------------|----------------------------------|-------------------|
| | | Cellulose | Cellulose acetate |
| -OH | 3700-3300 | 3431.1 | 3340.5 |
| C-H | 3030-2853 | 2916.2 | 2896.9 |
| C-O (ester) | 1275-1200 | - | 1244.0 |
| C-O | 1160-1025 | 1110.9 | 1074.3 |
| C=O | 1750-1730 | - | 1733.9 |

Figure 2 shows the morphology of cellulose and cellulose acetate with a magnification of 10,000 times. Morphology of cellulose appears that the surface is uneven, whereas in cellulose-acetate the surface morphology is more even. The cellulose acetate surface is more homogeneous than cellulose. Table 2 represents the element of cellulose and cellulose acetate. The increase element O in cellulose acetate indicates that the acetylation process has succeeded.

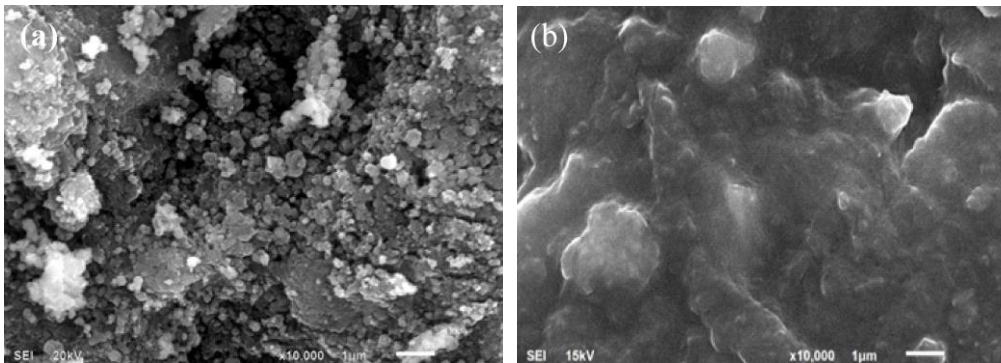


Figure 2. Morphology of (a)cellulose and (b)cellulose acetate

Table 2. The element of cellulose and cellulose acetate

| Element | Cellulose (%) | Cellulose acetate (%) |
|---------|---------------|-----------------------|
| C | 89.89 | 66.80 |
| O | 4.11 | 30.71 |
| Na | 1.13 | - |
| Mg | 0.55 | - |
| Si | 2.62 | 1.49 |
| Cl | 0.62 | 0.20 |
| K | 0.30 | - |
| Ca | 0.78 | 0.81 |

3.2. Removal of Methylene Blue by Cellulose Acetate

The effect concentration of dye was observed in the range of methylene blue concentration 10-100 mg/L and amount of adsorbent 0.1 g. Figure 2 shows the effect methylene blue concentration on the adsorption of methylene blue (mg/g). Increasing the concentration of the dye increased adsorption capacity. The highest adsorption at a concentration of 90 mg/L with adsorption capacity was 34.123 mg/g for cellulose and 36.752 mg/g for cellulose acetate. A decrease in adsorption capacity can be caused by the adsorbent is saturated. The adsorption mechanism can occur through various methods such as complexation, pore, ion exchange. Removal of methylene blue using cellulose acetate occurs physically in the presence of pores of adsorbent and an electrostatic pull between cellulose acetate and methylene blue. The electrostatic attraction is influenced by the pH of the solution.

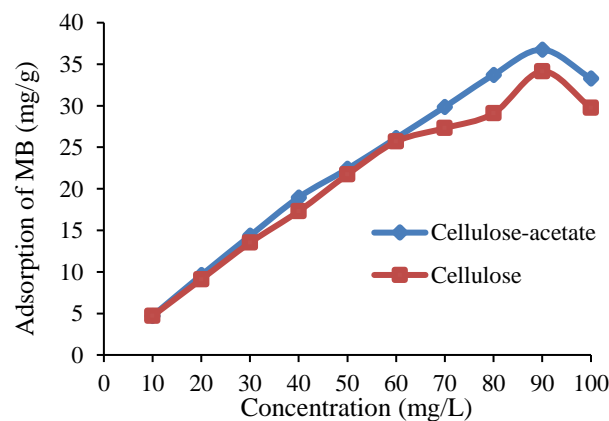


Figure 3. Effect of dye concentration (mg/L)

The influence of pH on the adsorption of methylene blue can be seen in Figure 3. The optimum pH solution for removal methylene blue at pH 6.0 for cellulose and cellulose acetate. Methylene blue is a cationic dye has a positive charge in the solution. This similar with removal blue using cellulose from banana peels obtained optimum at pH 6 and pH 7 [10]. At acidic pH, the adsorbent will be protonized so that the charge on the adsorbent is positive and tends to the rejection of methylene blue which is also positively charged $[(C_{16}H_8N_3S)^+]$. This causes the low dye to be adsorbed in acidic solution [4]. At alkaline pH, reduced H^+ ion and increased OH^- ions in the solution, and so there is competition between the O groups derived from the adsorbent with OH^- from the solution [18].

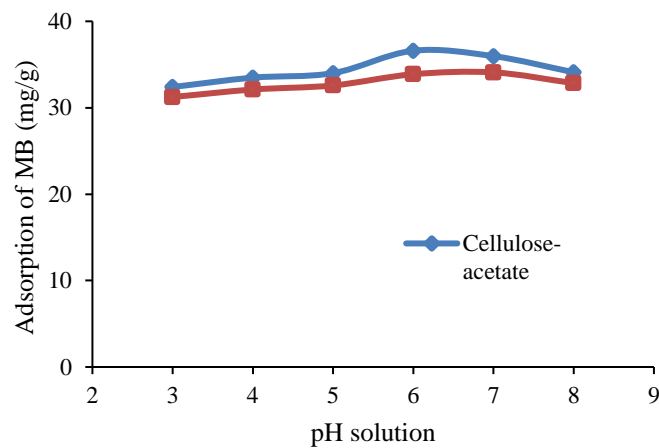


Figure 4. Effect of pH solution

Figure 4 shows the effect of contact time on cellulose and cellulose acetate adsorption capacity. Initially the adsorption capacity increases and then it is relatively constant. At contact time of 30 minutes equilibrium has been reached where the adsorbent is saturated in both cellulose and cellulose acetate. The adsorption rate occurred in the initial period because many sites were available. The longer the contact time, the active site to be limited and there is a decrease in adsorption.

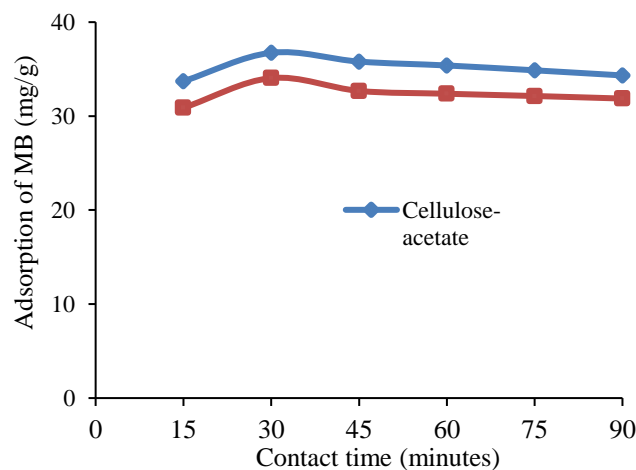


Figure 5. Effect of contact time

The adsorption process can occur in one step or several steps depending on many factors. The kinetics models describe the adsorption mechanism. In this research, pseudo-first order and pseudo-second order were used to determine the appropriate order kinetic model. Table 3 shows kinetics adsorption data the methylene blue onto cellulose and cellulose acetate. The value of correlation coefficient (R^2) on pseudo-second order is greater than pseudo first order, so the kinetics of pseudo-second order is more suitable to describe the adsorption order kinetics model for adsorption methylene blue using cellulose and cellulose acetate.

Table 3. Kinetic adsorption parameters

| Parameters | Cellulose | | Cellulose acetate | |
|---------------------------------|--------------------|---------------------|--------------------|---------------------|
| | Pseudo-first order | Pseudo-second order | Pseudo-first order | Pseudo-second order |
| R^2 | 0.8986 | 0.9967 | 0.9733 | 0.9986 |
| K_1 (min ⁻¹) | 0.0255 | - | 0.0198 | - |
| K_2 (g/mg min ⁻¹) | - | 0.00016 | - | 0.00023 |
| q_e (mg/g) | 54.121 | 46.445 | 52.889 | 42.626 |
| q_{eksp} (mg/g) | | 34.051 | | 36.741 |

The adsorption equilibrium was analyzed using Langmuir and Freundlich isotherm. Table 4 shows data on isotherm Langmuir and Freundlich parameters. Adsorption of methylene blue using cellulose and cellulose acetate is more appropriately described using Langmuir isotherm. One dye molecule will occupy one site on the surface of the adsorbent. The correlation coefficient (R^2) for Langmuir isotherm was greater than that of Freundlich Isotherm. R_L describes the dimensions parameter. This value shows the adsorption intensity [12]. The value of R_L is obtained for 0.024 for cellulose and 0.018 for cellulose acetate, so adsorption is favorable process ($R_L < 1$). Cellulose acetate has an adsorption capacity of 42.107 mg/g, greater than cellulose 39.983 mg/g.

Table 4. Isotherm adsorption parameters

| Isotherm | Parameters | Value | |
|------------|---------------|-----------|-------------------|
| | | Cellulose | Cellulose acetate |
| Freundlich | R^2 | 0.9587 | 0.9525 |
| | K_F | 12.990 | 9.310 |
| | $\frac{1}{n}$ | 0.4896 | 0.3958 |
| Langmuir | R^2 | 0.9909 | 0.9959 |
| | q_m | 39.983 | 42.107 |
| | K_L | 0.024 | 0.018 |
| | R_L | 0.0393 | 0.0385 |

4. Conclusions

In this study, modification of cellulose with acetic acid was synthesized and characterized. Cellulose was extracted from kepok banana peel. Cellulose acetate has the ability to removal methylene blue in solution greater than cellulose. The kinetic adsorption of the methylene blue on cellulose acetate following pseudo-second order and adsorption isotherm according to isotherm Langmuir. Cellulose acetate has the ability to removal methylene blue greater than cellulose. Thus, the addition of the acetate group increases the adsorption capacity.

Acknowledgments

This research was funded from “Unggulan Kompetitif Universitas Sriwijaya 2015”. The author would like to thanks to Department of Chemistry and Sriwijaya University for financial support and research facilities.

References

- [1] Rafatullah M, Sulaiman O, Hashim R and Ahmad A 2010 *J Hazard Mater* **177** 70
- [2] Afroze S, Sen T K, Ang M and Nishioka H 2016 *Desalin. Water Treat.* **57** 5858
- [3] Pathania D, Sharma S and Singh P 2017 *Arab. J. Chem.* **10** 445
- [4] Toumi L B, Hamdi L., Salem Z and Allia K 2015 *Desalin. Water Treat.* **53** 806
- [5] Mahmoodi N M 2015 *Desalin. Water Treat.* **53** 84
- [6] Wu J S, Liu C H, Chu K H and Suen S Y 2008 *J. Membrane Sci.* **309** 239
- [7] Guibal E and Roussy J 2007 *React. Funct. Polym.* **67** 33
- [8] Gebru K A and das C 2017 *J. Water Proc. Eng.* **16** 1
- [9] Aljeboree A M, Alshirifi A N and Alkaim A F 2017 *Arab. J. Chem.* **10** 381
- [10] Annadurai G, Juang R S and Lee D J 2002 *J Hazard Mater* **10** 263
- [11] Vakili M, Rafatullah M, Salamatinia B, Abdullah A Z, Ibrahim M H, Tan K B, Gholami Z and Amouzgar P 2014 *Carbohydr. Polym.* **113** 115
- [12] Miyah Y, Lahrichi A, Idrissi M, Khalil A and Zerrouq F 2018 *Surf. Interfaces* **11** 74
- [13] Ur Rehman M S, Kim I and Han J I 2014 *Carbohydr. Polym.* **90** 1314
- [14] Hokannen S, Bhatnagar A and Sillanpaa M 2016 *Water Res.* **91** 156
- [15] Hariani P L, Riyanti F and Asmara R D 2016 *Molekul* **11** 135
- [16] Ragah T I M, Wasfy A A F, Amer H, El-Gendi A, Hady M S A and Liebner F 2014 *J. Appl. Sci.* **14** 3424
- [17] Das AM, Ali A A and Hazarika M P 2014 *Carbohydr. Polym.* **112** 342
- [18] Liu L, Fan S and Li Y 2018 *Int. J. Environ. Res. Public Health* **15** 1321