IOP Conference Series:
Materials Science and
Engineering

PURPOSE-LED
PUBLISHING™

PAPER • OPEN ACCESS

Preparation and characterization of cellulose biofilm from coastal pandanus (*Pandanus odorifer*) leaves

To cite this article: Aswin Falahudin *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **546** 042007

View the article online for updates and enhancements.

You may also like

- Microwave-assisted extraction of chlorophyll and polyphenol with antioxidant activity from *Pandanus amaryllifolius* Roxb. in Vietnam
Nguyen Hong Khoi Nguyen, Nguyen Thi Diem An, Phan Kim Anh et al.
- Antioxidant Activity, Organoleptic and Consumer Preference Test of Moringa oleifera Leaf Herbal Tea with the Addition of Natural Flavor Variation
Sulastri, T Wahyuni and Rahmad Rizki Fazli
- The utilization of Pandan Coconut (*Pandanaceae*) at the interior tribes Papua, Indonesia
L I Zebua, I M Budi, E Wanimbo et al.

This content was downloaded from IP address 87.49.42.148 on 10/10/2026 at 16:39

IOP Conf. Series: Materials Science and Engineering **546** (2019) 042007 doi:10.1088/1757-899X/546/4/042007

Preparation and characterization of cellulose biofilm from coastal pandanus (*Pandanus odorifer*) leaves

Aswin Falahudin[1], Putjha Melati[1], Herlina[1], Agus Mailiza[1], Morina Adfa[1], Irfan Gustian[1] and Salprima Yudha S[1*]

[1]Department of Chemistry, Faculty of Mathematics and Natural Sciences, Bengkulu University, Indonesia

*Corresponding Author: salprima@unib.ac.id

Abstract. The main objective of this report is the preparation and characterization of cellulose biofilm from coastal pandanus (*Pandanus odorifer*) leaves. The first experiment parts is the preparation of coastal pandanus leaves biofilm using a simple dissolution method followed by casting evaporation technique. Further experiments are the characterization of the produced biofilm using Scanning Electron Microscopy (SEM) in order to investigate the morphology of biofilms of pandanus leaves and Energy Dispersive X-ray (EDX) analysis to detemine their main composition. In addition, Fourier Transform Infra-Red (FT-IR) spectroscopy analysis was carried out to compare the main functional groups in the coastal pandanus leaves against to the corresponding biofilm. The SEM analysis shows that, the coastal pandanus cellulose biofilm has almost homogenous morphology. The EDX analysis shows te main elements in the corresponding films were carbon and oxygen (48.19% mass and 38.42% mass, respectively). Based on the FTIR observation, the use of TFA as solvent has impact to functional groups stability of the raw material.

1. Introduction

Cellulose is biodegradable and bio-compatible material that has some advantages for many purposes such as raw precursors for polymer manufacturer and other cellulose-based industries [1, 2]. Some reports on the use of the cellulose for preparation of nanofibrils and cellulose films have been reported in recent decade. For instance, cellulose nanofibrils and their corresponding films were fabricated from various raw materials; banana, sugar, beet, hems, softwood and hardwood pulps in the presence of sorbitol as plasticizer [3]. In addition, the use of different plasticizers such as sorbitol, glycerol, and carboxymethylcellulose in the preparation of cellulose films using ionic liquid 1-allyl-3-methylimidazolium chloride as their solvent were also reported. The cellulose film with the best thermal stability was obtained using glycerol as plasticizer [4]. Moreover, current result shows that, the cellulose films prepared in a solution system of NaOH/urea/ZnO gives a film with tensile strength, thermal stability and optical properties better than in a solution system of NaOH/urea only [5]. Besides that, the use of sulphuric acid 20% (aqueous solution) was effective to obtain regenerated-cellulose films [6]. The use of N-methylmorpholine-N-oxide (NMMO) as coagulation agent in the preparation of regenerated cellulose films was also reported, recently [7].

Cellulose could be used for the preparation of functionalized composites. For example, incorporation of chitosan nanoparticles into celluose films was carried out to obtain cellulose films with antimicrobial

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

activity. One of the important results is the presence of chitosan nanoparticles in cellulose films gives antibacterial activity, better than the bulk chitosan itself [8]. Other cellulose composites could be obtained by combination of cellulose with starch or lignophenols [9]. Moreover, functionalization of cellulose using compatible compounds could be carried out via several strategies. An example, thiol-grafted cellulose films was achieved using alkoxysilane followed by thiol-ene reactions [10]. In addition, other result shows that microfibrilated cellulose combined with melamine formaldehyde gives composite with high mechanical damping [11].

From a practical point of view, the characteristics of natural biofilm, particulary their chemical compositions and dimensions depend on the selected resources and preparation methods. Therefore, in the present study, cellulose biofilm was prepared from a non-edible source; coastal pandanus (*Pandanus odorifer*) leaves using trifluoroacetic acid as solvent. The produced pandanus biofilm was studied with respect to morphology and their functional groups.

2. Material and Method

2.1. Materials

The coastal pandanus (*Pandanus odorifer*) leaves taken from Bengkulu city coastal region and washed using aquadest. The leaves cut to pieces using scissor and kept in laboartory at room temperature until they were air-dried. Trifluoroacetic acid (TFA) purchased from sigma-Aldrich.

2.2. Procedures

The preparation of coastal pandanus cellulose biofilm was employed following the known procedure with slight modification [12]. For instance, the air-dried coastal pandanus leaves ground into powder (75 μM) using fruit juice-mixer. Trifluoroacetic acid (TFA) 100 mL was added to the powder of coastal pandanus leaves (3 gram) in Erlenmeyer (250 mL). The mixtures kept in shaker machine for 2 hours. The mixture kept at room temperature for 3 days. The coastal pandanus biofilm was obtained by simple solution casting method in a Petri-dish. The produced biofilm was characterized using FT-IR spectroscopy and SEM/EDX analysis.

3. Results and Discussion

The simple preparation of coastal pandanus biofilm is demonstrated in Figure1

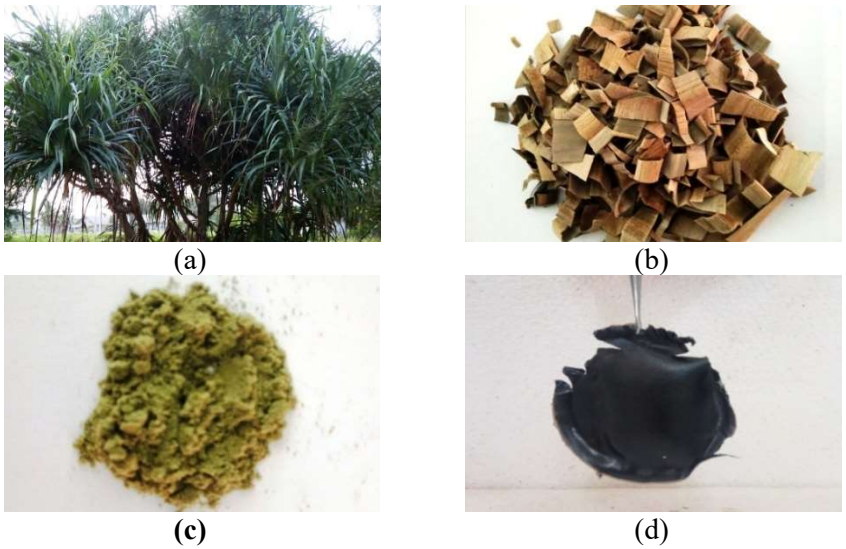
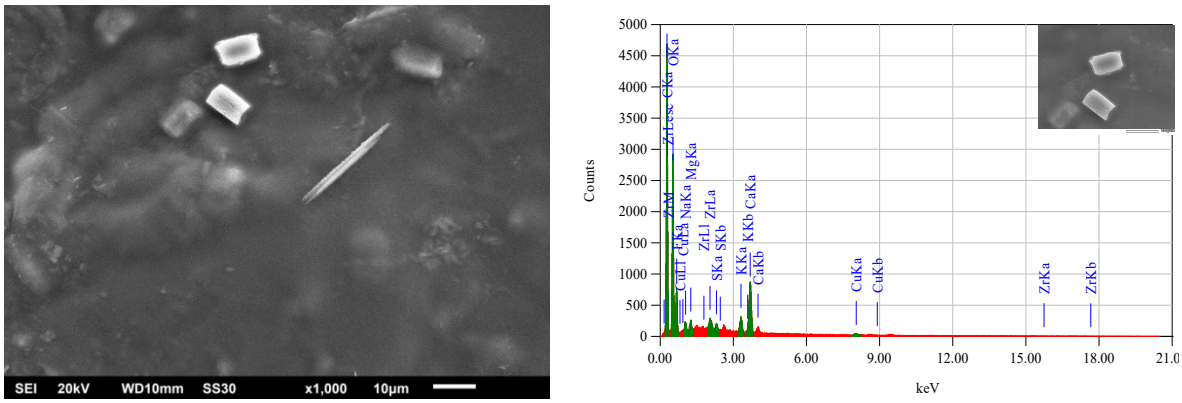


Figure 1. The selected preparation of coastal pandanus biofilm : (a) coastal pandanus trees, (b) air-dried coastal pandanus leaves, (c) the powder of coastal pandanus leaves, (d) coastal pandanus cellulose biofilm.

Based on Figure 1, the preparation of coastal pandanus cellulose biofilm was started by the sample collection and treatment of the pandanus leaves (Figure1(a) and 1(b)), followed by their powder preparation using juicer machine in dry condition to give yellow-green powder (Figure 1(c)). When TFA was added to the powder in an Erlenmeyer, the powder's colour immediately changed to brown. The mixture was allowed at room temperatue for 3 days followed by gentle evaporation of the solvent in Petri-disc at room temperature for 3 days. Finally, a black film was obtained as shown in Figure 1(d). The biofilm as shown Figure 1 (d) is considered as result of the slow growth mechanism for the cellulose solidification process from the cellulose-TFA solution system. Black colour, almost homogenous morphology and not too flexible film was produced by this method. In addition, it can be observed by naked eye that the produced cellulose film has rough surface.

3.1. Scanning Electron Microscopy-Energy Dispersive X-ray coastal pandanus cellulose biofilm

To elucidate the morphology and elemental composition of coastal pandanus cellulose biofilm, a combination of scanning electron microscopy (SEM) and Energy Dispersive X-ray were used to probe tha surface characteristic of the film (Figure 2).



(a) (b)

Figure 2. (a) SEM photographs showing morphology of coastal pandanus cellulose biofilm prepared by simple casting from cellulose-TFA solution (b) EDX difractogram of selected area of coastal pandanus cellulose biofilm.

Figure 2(a) shows SEM micrographs of the coastal pandanus biofilm consisted of some non-fibrils in microns and smooth surface of the film was observed. The fibrous components were not observed clearly, due to the disappearance of unstable compounds in TFA solvent. The EDX analysis as shown in Figure 2(b) shows the elemental composition of the coastal pandanus biofilms. The main elements were carbon and oxygen (48.19% mass and 38.42% mass, respectively) which was in agreement with other studies from other natural sources [13-15]. Other elements were embedded in the film: F, Na, Mg, S, K, Ca, Cu and Zr. The presence of Flour elements is assumed coming from used TFA.

3.2. Fourier-Transform Infra-Red analysis coastal pandanus cellulose biofilm.

The FTIR spectra of coastal pandanus (*Pandanus odorifer*) leaves cellulose and the correspponding biofilm are shown in Figure 3.

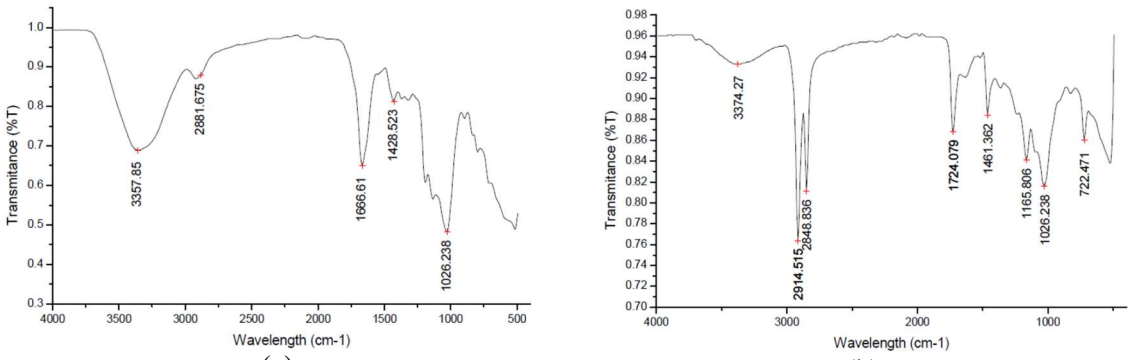


Figure 3. FT-IR spectra (a) coastal pandanus biofilms and (b) Air-dried coastal pandanus

Based on Figure 3, all samples presented some main absorbance regions in the rangeof 1000-4000 cm^{-1}. Both spectra have shown a wide band in the range of 3300 – 3600 cm^{-1} that corresponding to OH stretching vibration of the OH functional group in cellulose [16-17]. The main difference of the peaks in both spectra detected around 2700-3000 cm^{-1} related to C-H stretching vibration. In the raw material, two sharp peaks at 2914 cm^{-1} and 2848 cm^{-1} were detected (Figure 3(b)). In contrast, the corresponding peaks intensity decreased significantly in the coastal pandanus biofilms (Figure 3(a)).This phenomenom probably caused by removal of unstable organic compounds in the raw material when it was treated using TFA.

4. Conclusion

The coastal pandanus cellulose biofilm was succesfully prepared through the TFA-cellulose solution system. SEM image showed that the coastal pandanus biofilms has almost homogenous morphology. The use TFA as solvent has impact to the functional groups stability of the raw material judged by FTIR. The development of coastal pandanus leaves for composites preparation and their application will be explored in the future.

Acknowledgement

The authors gratefully acknowledged the financial support provided by the Ministry of Research, Technology, and Higher Education of Republic of Indonesia (Kemenristekdikti) under the Hibah Tim Pascasarjana 2018. Thanks Mr. Deni Agus Triawan who helped us to operate the FT-IR spectrophotometer in Laboratory of Chemistry, Universitas Bengkulu.

References

[1] Kim K B and Kim J 2013 Fabrication and characterization of electro-active cellulose films regenerated by using 1-butyl-3-methylimidazolium chloride ionic liquid, *Proc.I Mech E Part C: J. Mech. Eng. Sci*., **227(12)** 2665-2670

[2] Klenn D, Heublein B, Fink H P and Bohn A 2015 Cellulose: Fascinating biopolymer and sustainable raw material, *Angew Chem intl. Ed*., **44** 3358-3393

[3] Vartiainen J, Lahtinen P, Kaljunen T, Kunnari V, Peresin M S and Tammelin T 2015 Comparison of properties between cellulose nanofibrils made from banana, sugar beet, hemp, softwood and hardwood pulps, *Revista O Papel*., **76** 51-54

[4] Pang J, Liu X, Zhang X, Wu Y and Sun R 2013 Fabrication of cellulose film with enhanced mechanical properties in ionic liquid 1-allyl-3-methylimidaxolium chloride (AmimCl), *Materials,* **61** 270-1284

[5] Yang Q, Qin X and Zhang L 2011 Properties of cellulose films prepared from NaOH/urea/zincate aqueous solution at low temperature, *Cellulose,* **18** 681-688

[6] Zhou J, Zhang L and Shu H 2002 Regenerated cellulose films from NaOH/urea aqueous solution

by coagulating with sulfuric acid, *J. Macromol. Sci Physics.,* **B41(1)** 1-15
[7] Ichwan M, Son T W 2012 Preparation and characterization of dense cellulose film for membrane application*, J. Applied Polymer Science*, **124** 1409-1418
[8] Romainor A N B, Chin S F, Pang S C and Bilung L M 2014 Preparation and Characterization of Chitosan Nanoparticles-Doped Cellulose Films with Antimicrobial Property, *J. Nanomaterials,* **2014** 1-10
[9] Harlin A, Tammelin T, Nousiainen, Vehviläinen M, Kamppuri T, Karppinen and Kolppo K 2010 Preparation of cellulose-starch and cellulose-lignin film *in* "Developments in advanced Biocomposites, *Julkaisija – Utgivare- Publisher*
[10] Tingaut P, Hauert R and Zimmermann T 2011 Highly efficient and straightforward functionalization of cellulose films with thiol-ene click chemistry, *J. Mater., Chem.,* **21** 16066-16076
[11] Henriksson M and Berglund L A 2007 Structure and properties of cellulose nanocomposite films containing melamine formaldehyde *J. Applied Polym. Sci.,***106** 2817-2824
[12] Bayer I S, Puyol S G, Guerrero J A H, Ceseracciu L, Pignateli F, Ruffilli R, Cingolani R and Athanassiou A 2014 Direct transformation of edible vegetable waste into bioplastics *Macromolecules Macromolecules.* **47** 5135–5143
[13] Adekoya M A, Oluyamo S S, Oluswasina O O and Popoola A I 2008 Structural characterization and solid state properties of thermal insulating cellulose material of different size classifications, *BioResources,***13(1)** 906-917
[14] Kumar A, Negi Y S, Choudhary V and Bhardwaj N K 2014 Characterization of cellulose nanocrystals produced by acid-hydrolysis from sugarcane bagasse as agro-waste, *J. Materials Physics and Chemisty,* **2(1)** 1-8
[15] Krishnan N V and Ramesh A 2013 Synthesis and characterization of cellulose nanofibers from coconut coir fibers, *IOSR J. Applied Chemistry*, **6(3)** 18-23
[16] Sofia M R K, Brown R J, Tsuzuki T and Rainey T J 2016 A comparison of cellulose nanocrystals and cellulose nanofibres extracted from bagasse using acid and ball milling methods, *Adv. Nat. Sci.: Nanosci. Nanothecnol.,* **7** 035005 9
[17] Li J, Wang Y, Wei X, Wang F, Han D, Wang Q and Kon L 2014 Homogeneous isolation of nanocelluloses by controlling the shearing force and pressure in microenvironment, *Carbohydrate Polymers,* **113** 388-393