# Characterization Of Cellulose Nano Fiber From Solid Waste Of Palm Oil Palm Empty Fruits As Basic Materials Of Bioplastic For Food Packaging

Efrizal Siregar[1*], Yusnia Sinambela[2], Khairil Anwar[3]

{efrizalsiregarchems@gmail.com[1], belasinambela@gmail.com [2], rielone4u@gmail.com[3]}

Departement of graphic technique Politeknik Negeri Media Kreatif, Indonesia[1,2]
Departement of Graphic Design, Politeknik Negeri Media Kreatif, Indonesia[3]

**Abstract.** Palm oil solid was of plantations that have not been maximally processed into something more useful. This research aims to synthesize empty oil palm fruit bunches through several stages combination method mechanical processes, chemical processes, and physical processes. The cellulose nanofibers that have been produced are then tested for characterization to see the potential of cellulose nanofibers as the basic material for making biodegradable bioplastics. The analyzes that have been carried out are X Ray Diffraction analysis (XRD), Fourier Transform Infra Red Analysis (FTIR), and morphological analysis of solid waste of empty palm oil fruit bunches converted into cellulose nanofibers. The results of characterization of solid waste of empty palm oil fruit bunches converted into cellulose nanofibers indicate that these nanocellulose fibers have the potential to be used as the basic material for making bioplastics that are environmentally friendly and biodegradable. XRD analysis shows that the difragtogram of nanocellulose fibers has a more significant crystallinity than other natural materials. FTIR analysis provides an overview of the molecular functional groups needed to be the basic material for the manufacture of environmentally friendly bioplastics. Likewise, the results of the morphological analysis of solid waste of empty palm oil fruit bunches converted into cellulose nanofibers have superior quality which can be used as bioplastic film composites.

**Keywords:** Oil palm empty Bunches, Nanofiber Celluose, Bioplastic, Food Packaging.

## 1 Introduction

North Sumatra is one of the provinces in Indonesia as the largest producer of oil palm plantations. In 2020, the Central Statistics Agency (BPS) recorded the largest smallholder oil palm plantation area in North Sumatra, which was 440 thousand hectares with production reaching 7 million tons. After the palm fruit is taken as a fresh fruit mark, the empty fruit bunches will become solid palm dregs. Solid palm dregs have 23% of the weight of fresh fruit bunches with a cellulose content of about 38.76% [1]. This cellulose content can be used for various purposes. One of them is as a filler material as a PVA filler material so as to form a composite.

Palm solid waste has a large cellulose content abundant macro molecule in nature which can be easily derived from available biomass. Nano cellulose is also suitable for use in strengthening bioplastics because cellulose can produce nanomaterials with a high strength-to-

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weight ratio and is expected to have a lower cost of management when compared to other nanomaterials. Nano cellulose is biodegradable and environmentally friendly. Several research results state that cellulose has an exciting prospect to be able to add quality the mechanic and thermic properties of macro molecule [2]. Two types of cellulose nanostructures can be applied as reinforcement in food packaging materials, namely nanocrystal cellulose and nanofibers. These two types of nano-cellulose can strengthen nano-polymer composites with higher strength and modulus due to a more significant aspect ratio and fiber bonding [3]. PLA is a type of compostable and biocompatible thermoplastic derived from renewable resources, such as corn, sugar cane, and potato starch. PLA nanocomposites are widely used in packaging applications. PLA has disadvantages in terms of high brittleness, low deformation at the peak, low fatigue strength, and a weak gas barrier relative to polyolefins [4].

Research conducted by Ramachandra [5] , synthetic coconut shells into cellulose nanofibers can be used to improve the quality of PVA film-based food packaging. The quality synthetic coconut shells into cellulose nanofibers has good quality, seen from the results of the characterization of cellulose nanofibers that have been carried out and nono-cellulose fibers can also be produced from other raw materials such as empty palm oil bunches. The synthesis of cellulose nanofibers can also be produced from areca nut raw materials by producing a percentage of 35% by mass [6]. Cellulose nanofibers produced from other natural sources can be used for various uses, such as in the health sector which can be used as implants, in the food industry, and as fillers for bioplastic films [7].

In this paper, palm solid waste is synthesized into cellulose fibers with a combination of mechanic, chemistry, and physic processes. From the research paper we can draw that the character of the cellulose nanofiber synthesized form oil palm drags has a better mass percent quality of the cellulose fibers when compared to the cellulose nanofibers synthesized from other materials.

## 2 Research Methods

The main raw material used is palm oil solid waste in the form of empty palm oil bunches which are commonly found in North Sumatra, Indonesia. Isolation of alpha cellulose fibers from empty oil palm fruit bunches processed using chemicals such as $HNO_3$, $NaNO_2$, $NaOH$, $H_2O_2$, $NaOCl$, PVA can be found at the Organo store in Medan, North Sumatra. The empty marks of oil palm are cleaned by washing with water to remove adhering impurities, then dried and weighed as much as 75 grams. The sample obtained was then heated by mixing 3.5% $HNO_3$ and $NaNO_2$ at a temperature of 90˚C using a hotplate for approximately 2 hours [8]. Then the empty bunches obtained were washed to get yellow fibers. The fiber was reheated for 1 hour at 50˚C with a mixture of 750 mL of 2% NaOH and 2% $Na_2SO_3$ to remove lignin and hemicellulose compounds contained in cellulose fibers. The fiber samples obtained were then bleached using 1.75% NaOCl at 70˚C for 30 minutes. The next step is the -Cellulose purification process with 500 mL of 17.5% NaOH at 80°C for 30 minutes and followed by bleaching using 10% $H_2O_2$ for 5 minutes at 70°C for optimal results. cellulose that is dry and white [9].

Cellulose fiber samples that have been obtained by mechanical processes are then pulverized using a blender. Cellulose fiber samples that have been chemically treated are then homogenized for ten minutes and ultrasonically for 20 minutes to get good cellulose nanofibers. To determine the characterization of the cellulose fiber obtained, it can be done to test the morphology, fiber size and test the content of chemical compounds contained in the cellulose fiber [6]. The research method desain can be seen from figure 1.

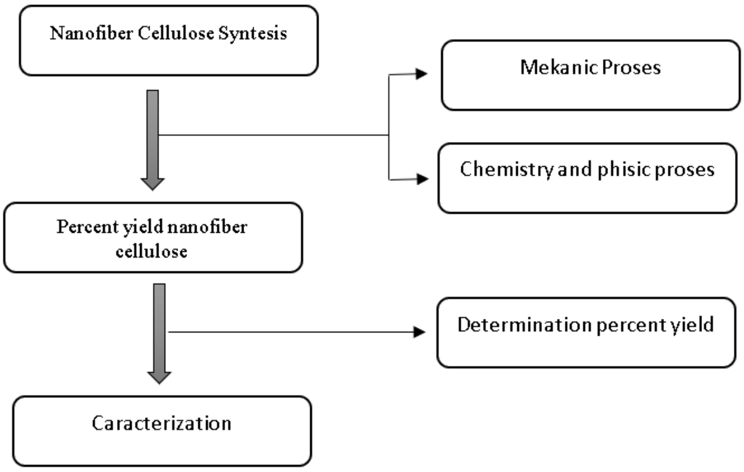


**Fig.1.** Research Method Desain

## 2.1 Nanofiber Particle Characterization

### 2.1.1 XRD Nanofiber Particle

X-Ray Difraction analysis of cellulose nanofiber samples of empty oil palm fruit bunches was carried out using the Shimadju XRD-7000 integrated laboratory UNDIP ( ) was used to identify crystalline materials and provide information about the dimensions of the sample cell units by chemical process. The scanning process was carried out close to the previous study with the initial position of 5.194 and the final position of 99.9864 the time needed to identify was 20.3200 seconds [10].

Crystal size (D) $= \frac{0{:}89\,\lambda}{\beta \cos \alpha}$ ( schrrer formula)

Crystal index percentage (%) $= \frac{\text{Ica}-\text{Ia}}{\text{Ica}}$ (segal formula)

Description : Ica is a combination of high crystal and amorf while Ia is height of amorfous.

### 2.1.2 FTIR (fourier transform infrared spctrtoscopy)

The characterization of cellulose fiber nanoparticles of empty oil palm fruit bunches was analyzed using the FTIR spectrum using a spectrometer at a wavelength of 4000-500 $cm^{-1}$ to determine the amount of cellulose, lignin content, and to determine the amount of cellulose content remaining after the dissolution process using chemicals at the beginning. test. The FTIR spectrum obtained was observed for analysis by comparing it to the spectrum table in the previous research report [11].

**2.1.3 Topography, morphology, and size nanofiber particle**

The morphology of the nano cellulose of oil palm empty fruit bunches was observed by sending samples to the UII Laboratory (Islamic University of Indonesia, Depok, Indonesia). The results of observations from cellulose nanofibers were taken at 20 m, 10 m, 5 m and 1 m magnets and then deposited on a device made of copper coated with carbon, close to what has been done in previous studies. The surface of the cellulose nanofibers was analyzed using a microscope by placing the nanoparticles on a glass slide with a magnification of 1 µm [12].

## 3. Result and Discussion

**3.1 Extraction of cellulose nanofiber from oil palm empty fruit bunches**

Palm oil solid waste such as oil palm empty fruit bunches is processed with various pretreatment methods that can produce good quality nanoparticles. The method is to reduce the content of lignin and hemicellulose contained in the empty bunches. The extraction process of cellulose nanofibers in this research is a combination of mechanical, chemical, and physical. Dry cellulose nanofibers were obtained by drying at a temperature of 120 $^{o}$C with a wind speed of 0.5 m3/minute and a humidity speed of 5.0 mL/minute. The mass percentage of cellulose nanofibers obtained after the drying process is 40.54%, the results obtained are slightly lower than the results of similar studies [1] [5] but are still superior to other raw materials such as 23.5% coir, coconut coir. 32.5%, bananas 28.6% and pineapples 40.1%. Images of cellulose fibers can be seen in Figure 2.

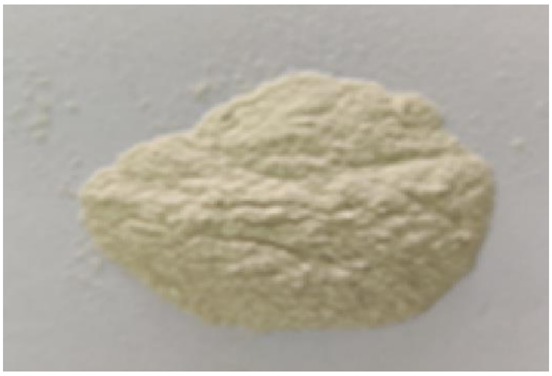

**Fig. 2. cellulose nanofiber from oil palm empty fruit bunches**

**3.2 XRD**

XRD diffractogram analysis of the cellulose fiber of oil palm empty fruit bunches is shown in Figure 3. The results obtained when compared with previous studies [1] will obtain the similarity of peaks on the cellulose fiber of empty oil palm empty bunches with the reference shown in table 1. Peak with intensity the largest is at 2θ = 15.2000 ; 20.3325 ; and 22.5264. The significant difference between the diffractograms of cellulose fiber from empty fruit bunches of oil palm where there was an increase in the intensity and narrowing of the diffraction band identified an increase in the crystallinity of the sample of cellulose fiber [13]. The results of previous studies from several renewable sources concluded that the crystallinity index of materials such as sisal (91.2%), banana (80.9), cotton (86.5%), coconut fiber (84.5%) and pineapple leaf (92.3%).

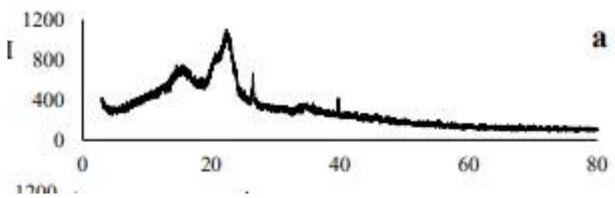


**Fig. 3. XRD analysis**

**Table 1.** The significant difference between the diffractograms of cellulose fiber from empty fruit bunches

| Difragtograms | Research result | Research result JKK |
|---|---|---|
| 2θ | 15.2000 | 15.3466 |
| 2θ | 20.3325 | 20.6400 |
| 2θ | 22.5264 | 22.2575 |

**3.3 Topography, morphology, and size nanofiber particle**

In this study, the cellulose nanofibers of oil palm empty fruit bunches were observed in the form of micro-sized crystals. Images of cellulose fibers are shown in Figure 4. In previous studies, the shape of the cellulose nanofiber structure depends on the extraction method [6]. To determine the size of cellulose nanofibers, TEM and AFM will be carried out with the size of cellulose fibers ranging from 27.4-29.8 nm as a form of aggregate network structure that will increase the stability of the polymer strength. The particle size of cellulose nanofibers obtained in this study is similar to the particle size of previous studies [13].

## 4. Conclusion

Based on the results and discussion of the research that has been carried out, the synthesis of cellulose nanofibers from oil palm empty fruit bunches was successfully synthesized. The weight percent of cellulose nanofibers obtained is in accordance with the results of previous studies. The FTIR characterization of cellulose nanofibers of oil palm empty fruit bunches gave significant results in crystallinity and crystalline size. The SEM results show that the more cellulose added, the wider the surface of the cellulose will be. Based on the characterization of the cellulose nanofibers produced, the non-cellulose fibers from oil palm empty fruit bunches meet the standards to be used as the basic material for making bioplastics based on PVA biodegradable nano-composites.


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