EXTRACTION OF CELLULOSE AND PREPARATION OF NANOCELLULOSE FROM PALM EMPTY FRUIT BUNCHES FIBERS

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Abstract

In this work a study on the feasibility of extracting cellulose from Palm Empty Fruit Bunches fibers, by means of two different procedures was carried out. These processes included usual chemical procedures such as acid hydrolysis, chlorination, alkaline extraction, and bleaching. The first procedure was to prepare a stable water suspension of nanocellulose after treatment with sulfuric acid (H_2SO_4). In the second procedure, the nanocellulose were dispersed in an organic medium; dimethylacetamide/lithium chloride (DMAc/LiCl). The extraction procedures that were used led to purified cellulose.The final products were characterized by means X-Ray Diffraction (XRD) and Scanning Electron Microscopy (SEM). The resulting nanocrystal fibers sized 73 nm

Keyword : *Cellulose, Palm Empty Fruit Bunches fibers, Extraction procedures, Characterization, Nanocellulose*

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INTRODUCTION

Cellulose is a sustainable and renewable natural material. As a chemical raw material, cellulose has been used in the form of fibers or derivatives for about 150 years.

In recent years, nanocomposite fibers and materials nanoselulosa attracted much interest due to extraordinary changes in the nature (Ibrahim et al, 2010). As reinforcement in composite material components, this natural fiber has its advantages such as a renewable, recyclable and can be biodegradable in the environment. In addition, natural fibers have good mechanical properties and less expensive than synthetic fibers.

Waste processing and utilization of oil palm plantations to achieve zero waste Production is being encouraged. Plantation and palm oil mills in Aceh Province, Indonesia, and in general, is growing very fast because it is a vegetable oil-producing potential. Simultaneously, production of crude palm oil (CPO) in the ground water is estimated to reach 13.6 million tons per year and as a result of the processing side of fiber to be obtained from the solid waste munitions and fiber seed, reached 20 million tons per year (Darnoko, 2006). Plant performance and oil palm plantations require operating cost savings and diversification of production to remain competitive in today's economic situation more and more competitive.

Cellulose derived from wood and non timber (empty fruit bunches oil palm, coconut fiber, etc.) is a highly abundant material existence on earth. This fiber material can be further processed into nanoselulosa that have distinctive properties such as very strong, the ratio of surface to volume ratio is large and highly porous (Subyakto et al, 2009). These properties make nano fibers are very promising materials for the composites industry, automotive materials, pulp and paper, electronics and other industries.

The backbone of the plant or tree is a polymeric carbohydrate with a structure known as the cellulose fibrils. These fibrils are composed of different microstructures, known as nano-size microfibrils that have a high structural strength. Nano-size fibrils is a combination of crystal and part amorfous, the crystal is called nanowhisker.

Several methods have been explored to achieve dispersion of crystal cellulose, or cellulose whisker, which refers to a needle-like structure, in a low polar solvent to a variety of matrices for nano composite process. Samir et al (2006), re-dispersing the cellulose whisker in organic solvents without the addition of surfactants or chemical modification.

Another challenge is the processing step by using the refining, bleaching, fibrillation, hydrolysis and also the low yield of the final dispersion of cellulose whisker. Acid hydrolysis of cellulose is a process that is known to release the amorfous and few studies have been reported in which the crystallites of cellulose / whisker is identified and separated from various sources.

There are several ways to prepare nano-size cellulose whisker chemically, the preparation technique first goal was to prepare stable colloidal liquid suspension of cellulose whisker after treatment with sulfuric acid. In the second way, the goal is to disperse whisker in organic media, DMAC / LiCl, to make a suspension in accordance with the polymers of low polarity (Daniel, et al, 2006).

Nano-sized cellulose fiber is a new material that can be used as a reinforcing material for polymers with MOE and tensile strength is much better than ordinary fiber (Subyakto, 2009). This is because the ratio of the diameter of the fiber length becomes smaller so that the tensile strength and MOE is much improved. Application can be added to polymers to create composites for the automotive, electronics, building materials and household appliances.

Dispersion nanoparticles into a polymer matrix which produces interesting properties. As a nanocomposite can be regarded as a solid structure with nanometer-scale dimensions are repeated in the distances between the different forms of constituent structure. Bonds between the particles that occur in the nanocomposite material plays an important role in the improvement of material properties and restrictions.

The particles are nano-sized has a high surface area of interaction. These interactions increase the mechanical strength of the composite is far above the strength of the polymer itself. The results can be achieved is a lightweight material with high strength (Bledzki et al, 2002).

The objective of this study is to provide the nanocrystal cellulose of Palm Empty Fruit Bunches fibers which will be used as reinforcing and filler in composites.

Method

- Provision of Oil Palm Fiber Empty Bunches (EFB)
- Delignification process-Bleaching
- Hydrolysis processes (manufacture of microcrystalline cellulose)
- Dispersion process (Making Nanocellulose)

2.2 Results

Figure 1 shows the physical aspects of the original EFB fiber and after bleaching with peroxide solution and alkaline solution.

Figure 1. The original EFB fiber and after bleaching

2. Exposition chapter

METHOD

Materials

Palm empty fruit bunches (EFB) fibers from Palm Oil Research Center, Medan (Indonesia). Reagents used are: nitric acid, sodium nitrite, sodium sulphite, sodium hydroxide, sodium Hypochlorite, hydrochloride acid, sulphuric asid, dimethyl acetamide, litium chloride (analytical grade).

XRD analysis performed to determine the crystallinity, also called the degree of order. X-ray diffraction pattern of fibers and bleached EFB after a microcrystalline fiber is shown in Figure 2a and 2b.

RESULT AND DISCUSSION

Both difraktogram featuring a mixture of cellulose polymorphs (typical peaks at 150 and 22.60) (Klemn et al, 2005). The percentage of crystallinity for bleached fibers after TKS was 75%, whereas for microcrystalline was 86%. Increase in crystallinity of cellulose fibers with microcrystalline cellulos bleaching results showed that the hydrolysis process in the formation of microcrystalline cellulose is complete.

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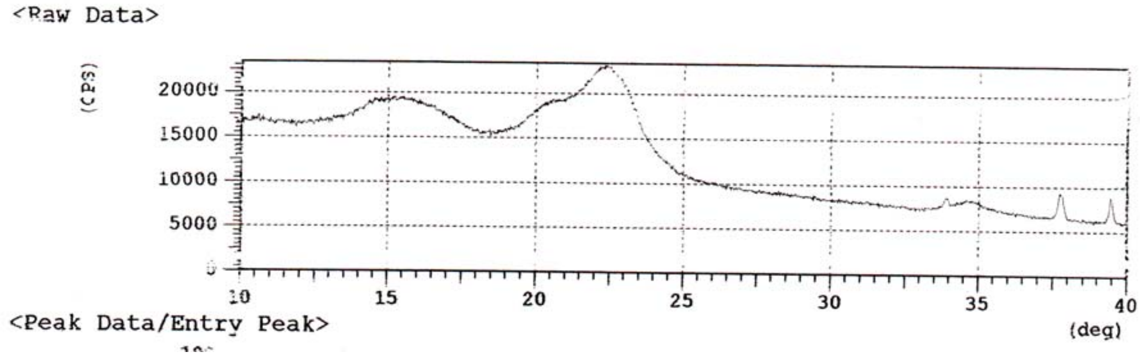

Figure 2a. XRD of EFB fiber after the bleached

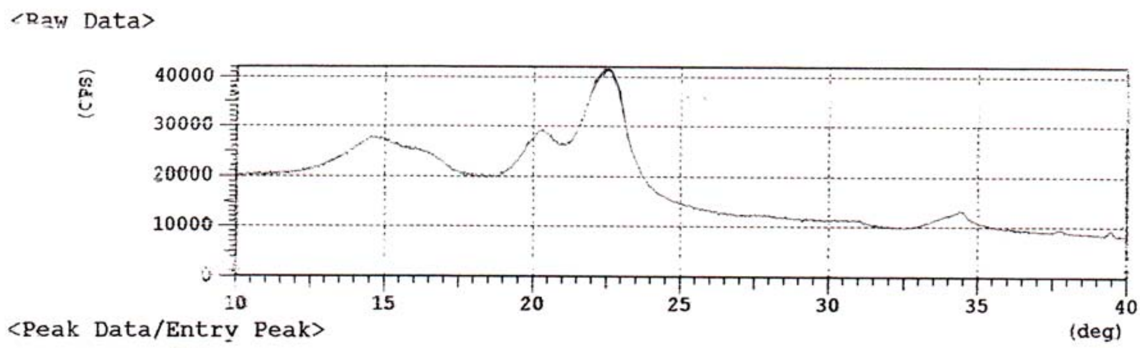

Figure 2b. XRD of cellulose mikrokrstalin

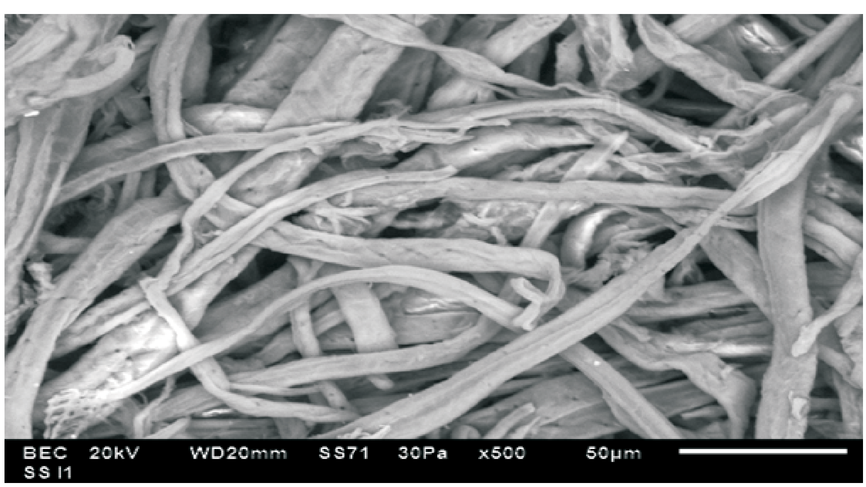

Figure 3a. Microcrystalline

Figure 3 shows the morphology of cellulose fibers with SEM EFB. 3a is an image of microcrystalline cellulose, microcrystalline image 3b hydrolysis results with sulfuric acid

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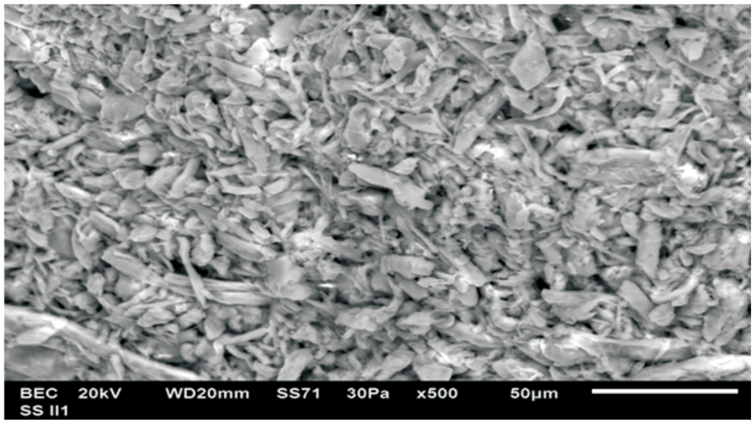
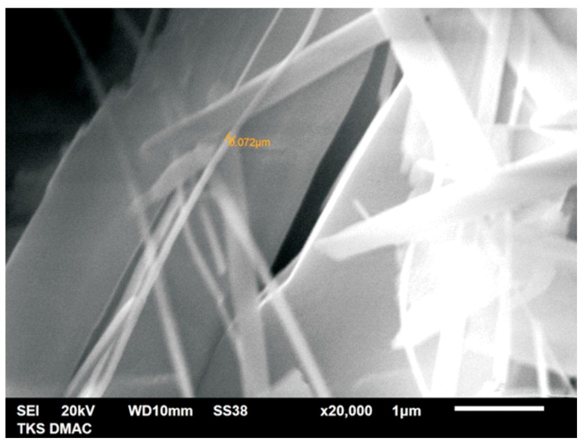


Figure 3b. The results of hydrolysis of microcrystalline cellulose with sulfuric acid



Picture 3c. The results of hydrolyzing microcrystalline cellulose in DMAC / LiCl

and microcrystalline image 3c is treated with lithium chloride-dimethyl asetamida. Results after acid hydrolysis of microcrystalline cellulose is 30% of initial weight. This is because the remaining amorphous microcrystalline separated during the hydrolysis. Also seen that the microcrystalline released during the process of washing / neutralization.

Meanwhile, the handling of microcrystalline cellulose in lithium chloride-dimethyl asetamida deliver nearly three times the initial weight of microcrystalline, the possibility of compound formation between microcrystalline cellulose with dimethyl asetamida / lithium chloride.From the figure above shows that the hydrolysis of microcrystalline cellulose are nano-sized, but not uniform, probably due to the hydrolysis of microcrystalline cellulose is not perfect and has not been optimal, because the influence of acid concentration and temperature of hydrolysis.

CONCLUSION

EFB fiber can be a source of cellulose for the manufacture of microcrystalline cellulose. EFB fibers can be bleached with solvents that are less aggressive to the environment (and alkaline peroxide solution). From the results of the XRD analysis, it appears that the resulting fibers are pure mikroselulosa (there is only one peak), while from the SEM analysis, the resulting cellulose fibers measuring 72 nanometers, but has not been uniform. Need for additional research to optimal operating conditions, in order to obtain the cellulose fibers from EFB fibers in a uniform nano size.

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