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ORIGINAL RESEARCH

MECHANICAL PROPERTIES OF CELLULOSE-BASED EXTRACTED FROM NATA DE COCO

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Abstract. *Paper production is currently important for various community needs due to the use in daily life. The aim of this study is to produce paper cellulose-based extracted from Nata de Coco with the addition of polyvinyl alcohol (PVA) as an adhesive. The paper was produced by using pulp method followed by ultrasonication with variation of ultrasonication from 10 min, 20 min, to 30 min. The sample was characterized in terms of functional groups and mechanical properties. The results showed that the longer the ultrasonication time, the lower the mechanical value. The highest tensile test was obtained at 10 min of ultrasonication with the value of 5.036 MPa.*

Keywords: *nanocellulose, nata de coco, paper, tensile test*

1. INTRODUCTION

Paper making is currently very important for people's needs, almost most of the world's people make paper as a source of their daily needs. Paper is currently growing very rapidly in the world industry. It is estimated that the world requires additional paper production of more than 100 million tons per year [1]. The high level of paper consumption has reduced the number of trees which are the raw material for making paper. It was recorded that 65–97 million trees were cut down to meet the paper needs of the workforce in Indonesia and around the world [2].

Paper production is made using basic materials containing cellulose. Cellulose can be found in wood fibers and then converted into semi-finished materials (pulp) and until now wood cellulose plays an important role or is the main ingredient used for the paper-making process. The need for pulp for papermaking continues to increase along with progress in activities using paper [3]. The process of making paper on wood containing cellulose still contains other materials such as lignin and hemicellulose which contain as much as 16% and 25% of softwood or needle leaf wood. Therefore, it is necessary to carry out the cellulose separation process [4].

Cellulose fiber has a very abundant amount in nature. Besides coming from plants, cellulose fiber is also obtained from bacteria. These bacterial cellulose fibers have sizes below 100 nm and are also referred to as nanocellulose. There are so many studies conducting research using cellulose fiber derived from bacteria and will be used as a raw material for making paper which is a new alternative and must be developed at this time. Bacterial cellulose can be produced by the cellulose bacterium Acetobacter Xylinum. Cellulose bacteria are also found in food, such as in the form of Nata de coco [5].

Nata or bacterial cellulose is white agar-agar produced from the fermentation of Acetobacter Xylinum bacteria using coconut water as the main ingredient and is named as Nata de coco. Nata de coco has a low calorific value, has a water content of more than 90% and has good cellulose fiber [6].

Cellulose from Nata de Coco will be used as a paper-making process to develop better paper-making production. Cellulose has advantages including low density, high chemical reactivity, high strength and modulus. These properties in cellulose have a very high potential use value and can be applied in a very wide variety of fields. One of them is as a production material for making paper [7]. Cellulose is also an environmentally friendly material and goes through a relatively cheap and simple process [8]

2. METHODOLOGY

Extracted Cellulose from Nata de Coco

Nata de coco was dried in the sun until it was grayish white. The dry nata de coco was mashed with a blender. Then the mashed Nata de coco was filtered using a Mesh sieve. After that, it was purified as following. Bacterial cellulose that has been obtained from Nata de coco was weighed 100 g. Bacterial cellulose was washed with distilled water until the pH was neutral. After that, the bacterial cellulose was soaked in 3% NaOH solution with 200 mL distilled water for 24 h. After soaking the bacterial cellulose, it is washed again with distilled water with a neutral pH. Bacterial cellulose was re-soaked in 5% NaOCl solution for 24 h. Then washed again with distilled water until the pH was neutral. Pure bacterial cellulose was obtained and then converted into nanocellulose using an ultrasonic homogenizer for 5 h.

Production of Paper Cellulose-Based

50 g of bacterial nanocellulose was put into a 250 mL beaker glass, added with distilled water and then stirred. Then 0.05 g of kaolin was added and stirred, 0.02 g of tapioca was added to the beaker glass, 5 ml of 50% H_2O_2 was added, then stirred until it became pulp. Plup was poured into a paper mold, then printed using a hot press at 110°C for 30 min. Then the experiment was repeated with variations in the bacterial composition of 75 g, 100 g and 125 g with the same treatment. Furthermore, bacterial cellulose paper was tested for functional group analysis by FT-IR, and mechanical properties.

3. RESULTS AND DISCUSSION

FTIR Analysis

FTIR spectrum analysis aims to determine the functional groups of components in the manufacture of paper from nanocellulose powder with the addition of kaolin, tapioca, and PVA.

Figure 1, 2 and 3 show FTIR of paper cellulose-based extracted from Nata de Coco. From Figure 1, it has characteristics, namely the presence of OH groups, CH_2, methylene, C-O ether, C-C vibrations. Based on Figure 1, a weak absorption band with a weak intensity is obtained in the 3691 cm^{-1} and 3346 cm^{-1} region wave numbers indicating the presence of the OH hydroxyl group, then in the 1426 cm^{-1} region a weak absorption band is obtained and the weak intensity indicates the presence of the CH_2 methylene functional group. At wave numbers 1319 cm^{-1}, 1163 cm^{-1}, 1110 cm^{-1} and 1002 cm^{-1} there is a moderate absorption band with wave intensities of 907 cm^{-1} and 752 cm^{-1}. There is a weak absorption band with moderate intensity indicating the presence of the C-C vibrational functional group.

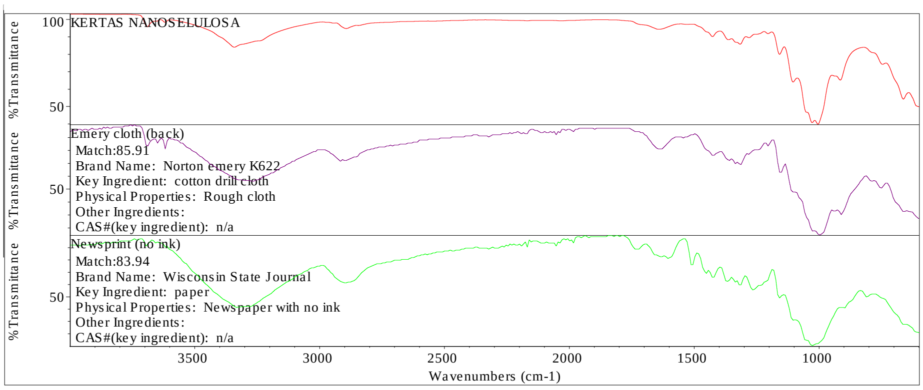

Figure 1. FTIR spectrum of cellulose paper-based

Figure 2 has a characteristic, namely the presence of a CH_2 methylene group, C-O ether. Based on the image above, a moderate absorption band with moderate intensity is obtained in the wave region of 1432 cm^{-1} indicating the presence of the CH_2 methylene functional group. At wave numbers 1306 cm^{-1}, 1104 cm^{-1}, 1158 cm^{-1} and 1026 cm^{-1} there is a sharp absorption band with medium intensity indicating the presence of the C-O functional group.

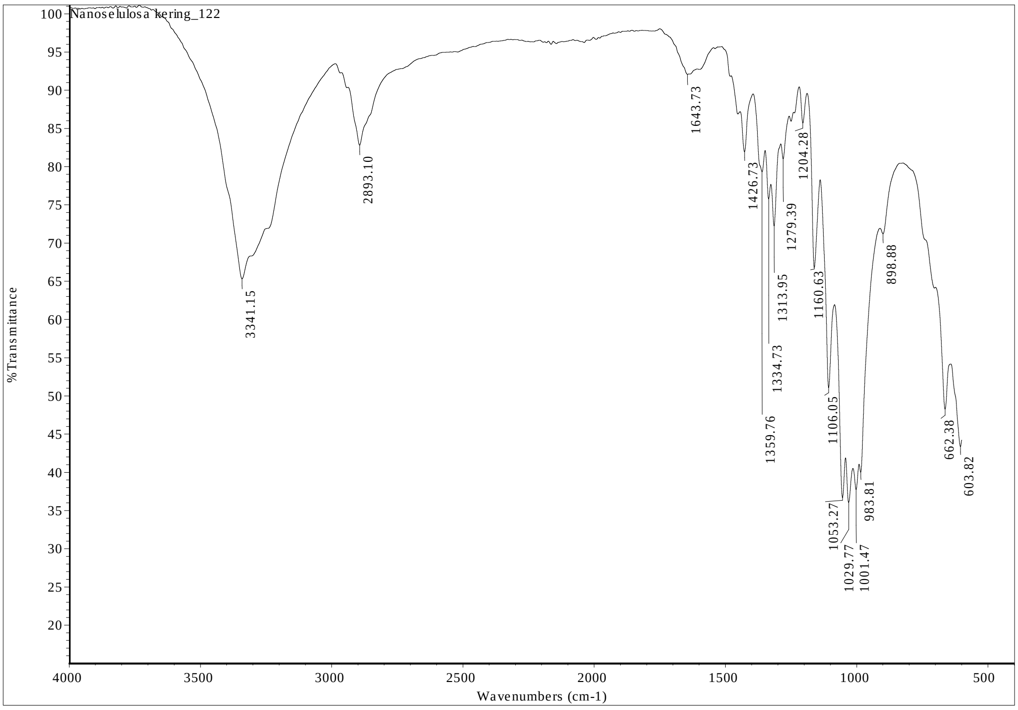

Figure 2. FTIR spectra of cellulose extracted from Nata de Coco.

Figure 3 has a characteristic, namely the presence of double C=O functional groups, C-H, C-O ether, C-C vibrations. Based on the figure above, a broad absorption band with weak intensity is obtained in the 1712 cm^{-1} wave number region indicating the presence of a doubled C=O functional group, then in the 1408 cm^{-1} wave number region a broad absorption band with weak intensity is obtained indicating the presence of C-H functional groups. In the wave number region of 1324 cm^{-1}, 1145 cm^{-1}, 1086 cm^{-1}, a broad absorption band with weak intensity indicates the presence of a C-O ether functional group, then in the region of wave number 830 cm^{-1} a moderate absorption band with moderate intensity indicates the presence of a C-C vibrational functional group.

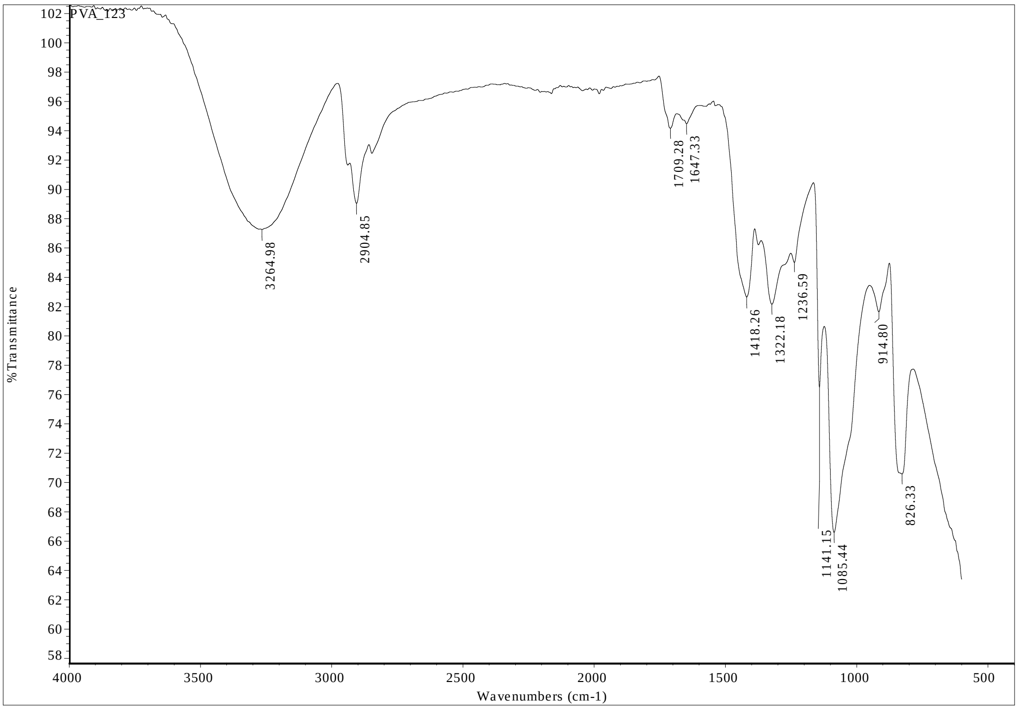

Figure 3. FTIR spectra Polivynil alcohol (PVA)

Mechanical Properties

Among all the time variations in the ultrasonication tool, the nanocellulose paper homogenizer with a time of 10 minutes has good tensile resistance with a modulus value of 60.53 MPa. This is because the 10-minute cellulose has particles that blend well with other materials.

For the paper tensile test, 3 samples were tested for tensile strength and compared between one composition and another between ultrasonic time variations in paper making. The tensile summarized in Table 1. From the Table, it can be obtained that the optimum tensile test for making paper at a time variation of ultrasonic cellulose is 10 minutes. For each tensile test of 10 minutes, 20 minutes and 30 minutes, among others: 5,036 MPa, 2,207 MPa and 1,772 MPa. From the results of the tensile test, it was found that the increasing time of cellulose ultrasonication can reduce the value of the tensile test in paper making.

Table 1. Elongation data of tensile strength test results of paper with cellulose ultrasonication times of 10 minutes, 20 minutes, and 30 minutes.

Ultrasonication (min)	Elongation
Cellulose 10	0.27914
Cellulose 20	0.19944
Cellulose 30	0.21942

4. CONCLUSION

From the difference in ultrasonication time, it can be seen that the higher the ultrasonication time in papermaking, the lower the tensile test value. The most optimum tensile test results were ultrasonication time of 10 minutes with a tensile test value of 5.036 MPa

5. ACKNOWLEDGMENT

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