



Manufacture and Analysis of Pulp With Palm Tree Fiber Raw Material on a Laboratory Scale

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ABSTRAK

Guna mendukung pemerintah mengatasi penyediaan pulp sebagai bahan baku kertas dalam negeri dan mengurangi ketergantungan bahan baku kayu, penggunaan bahan baku non-kayu seperti serat alam merupakan suatu cara yang dapat ditempuh untuk memproduksi kertas. Contoh serat alam yang sering kita jumpai sehari-hari adalah serat pohon aren. Pada penelitian ini telah berhasil dibuat pulp dengan menggunakan bahan serat pohon aren. Pulp dibuat dengan cara dimasak dengan mencampurkan bahan-bahan seperti larutan $BaCl_2$ 10%; HCL 0,1 N; Etanol 60%; PP (Phenolphthalein); Kanji 1%; Sindur Metil (SM), NaOH; Larutan Boraks; Na_2S Teknis; larutan THIO 1 N dan 0,1 N. Pemasakan menjadi pulp yang dilakukan selama 2+2 jam dengan suhu 170oC menggunakan mesin rotary digester. Serat kertas berbasis serat pohon aren yang dihasilkan dari pulp ini berukuran 20 μm .

ABSTRACT

In order to support the government to overcome the supply of pulp as domestic paper raw materials and reduce dependence on wood raw materials, the use of non-raw materials such as natural fibers is a way that can be reached to produce paper. Examples of natural fibers that we often encounter everyday are palm tree fibers. In this study, pulp has been successfully made using palm tree fiber material. Pulp is made by cooking by mixing ingredients such as 10% $BaCl_2$ solution; HCl 0.1 N; Ethanol 60%; PP (Phenolphthalein); 1% kanji; Sindur methyl (SM), NaOH; Borax solution; Technical Na_2S ; THIO 1 N and 0.1 N solution. Cooking into pulp is carried out for 2+2 hours with a temperature of 170oC using a rotary digester engine. Paper fiber based on palm tree fibers produced from this pulp measuring 20 μm .

1. INTRODUCTION

Currently, the material for making paper is still dominated by wood from trees. Almost 90% of the material used for making paper is wood. The current high demand for paper means that the possibility of forest exploitation will also increase (Rosmainar, 2017:62). In order to support the government in overcoming the supply of pulp as a raw material for domestic paper and reducing dependence on wood raw materials, the use of non-wood raw materials such as natural fibers is a way that can be taken to produce paper. An example of a natural fiber that we often encounter everyday is palm tree fiber.

Palm tree fiber (*Arenga Pinnata*), is a commodity in the plantation sector that is currently growing rapidly. Palm trees are spread throughout Indonesia, many of the palm trees can be used by local communities such as making sugar, oil, palm fruit, palm fiber and flour (Indrawanto, 2008:1).

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Palm tree fiber contains the following components: cellulose (60.61%), hemicellulose (15.74%), lignin (14.21%), reducing sugar (0.5689%), water (4.42%), and etc. Even palm fiber that has gone through a delignification process has an α -cellulose content of 95.74%, of which 50% of good cellulose is used as raw material for making pulp (Purnawan et al., 2011:28).

Therefore, palm tree fiber has the potential to be used as raw material for making pulp. Pulp is the result of separating fibers from fibrous raw materials (wood and non-wood) through various manufacturing processes (mechanical, semichemical, chemical). Pulp consists of fibers (cellulose and hemicellulose) as raw material for paper. The paper making process can be done by changing fiber raw materials into pulp and paper (Izzah, 2022).

The sequence of manufacturing processes is: Preparation of raw materials, pulp making (chemical, semichemical and mechanical), bleaching, chemical recovery, pulp drying and paper making. The processes that require the highest energy are the pulp making process and the paper drying process (Permatasari, 2021). In this research, pulp making using fiber from sugar palm tree trunks will be presented, the process is carried out chemically, namely fibrous raw materials added with chemicals.

2. METHOD

The tools used are beaker glass, pipette, analytical balance, propeller stirrer, magnetic stirrer, measuring flask, measuring cup, sharpening Erlenmeyer, aluminum container, oven, electric stove, desiccator, safety gloves, rotary digester machine, fiber grinding machine, tools pulp filters, pulp drying machines, manual paper making machines, paper printing equipment.

Meanwhile, the ingredients used consist of distilled water, NaOH (sodium hydroxide), KMnO_4 (potassium permanganate), Na_2S (sodium sulfide), sodium thiosulfate, H_2SO_4 (Sulfuric Acid), KI (potassium iodide), SM (methyl sindur), starch, I_2 (Lugol's Iodine), PP Indicator (Phenolphthalein), HCl (hydrochloric acid), BaCl_2 (barium chloride), Borax, Ethanol. At the pre-production stage a cooking solution is also made with the following stages: making technical NaOH solution, making 10% BaCl_2 solution, making 0.1N HCL solution, making 60% Ethanol solution, making PP (Phenolphthalein) indicating solution, making 1% KANJI indicating solution, making Methyl Synde (SM) indicator solution, NaOH titration, weighing Borax, making Borax solution, making technical Na_2S solution, making 1N THIO solution and making 0.1N THIO solution.

In the initial process, the raw materials to be used are prepared. Then prepare, manufacture, and determine the concentration of the cooking solution that will be used to make paper using palm fiber. If the cooking solution is ready and all stages of the chemical process have been passed, then the next stage is cooking the palm fiber to become pulp which is carried out for 2+2 hours at a temperature of 170°C using a rotary digester machine. After the cooking is complete, the cooked pulp is then washed and dried by machine.

When the pulp is dry, it is prepared for analysis and then the preparations needed for printing paper sheets will be carried out. Then the pulp is printed, after the pulp is printed and has become paper, the paper is characterized to determine the suitability of paper made from palm fiber. SEM (Scanning Electron Microscope) morphological properties testing was carried out to determine the shape and size of the particles that make up the paper. To determine the morphology, sugar palm fiber-based paper samples were characterized using a Scanning Electron Microscope or SEM. The SEM used in testing was a Zeiss Type EVO 50 with a voltage of 10 kV.

3. RESULT AND DISCUSSION

The pre-production process begins with preparing the raw material, namely palm fiber. Palm fiber undergoes a drying process to reduce the water content contained in it and is then cut into several pieces. Next, a chemical solution is made which is used for the process of cooking the raw materials into pulp. In this process the solution is calculated and analyzed how much solution will be used. The results of solution analysis produce the concentration in each solution.

Making the chemical solution begins by making a Technical NaOH solution, namely by preparing 4 liters of distilled water in a 5 liter glass baker, then 2 kg of NaOH is dissolved and left for one week. Next, make a 10% BaCl_2 solution, namely by diluting 100 grams of BaCl_2 with 1 liter of distilled water. Next is making a 0.1N HCL solution by dissolving 8.3ml HCL with 1 liter of distilled water and making a 60% Ethanol solution. PP (Phenolphthalein) indicator solution was also prepared by dissolving PP powder with 60% ethanol in a 100 ml volumetric flask. The next stage is making a 1% starch indicator solution, sindur methyl (SM) indicator solution, NaOH titration, making a borax

solution, technical Na₂S solution and making 1 N and 0.1 N THIO solutions. The process of making the cooking solution is shown in Figure 1.



Figure 1. Process of making cooking solution

The production or papermaking process generally includes cooking the pulp, washing and drying the cooked pulp, analyzing the cooked pulp, calculating the water and pulp requirements for printing and finally printing. The cooking process is carried out by preparing palm fiber samples, Making Technical NaOH Solution, Making 0.1 N HCl Solution, Making 10% BaCl₂ Solution, Making Ethanol 60 Solution, PP Indicating Solution, Making SM Indicating Solution NaOH Titration, Preparing 1% Starch Indicating Solution, Preparation of Borax Solution and Technical Na₂S Solution.

Making 1 N and 0.1 N THIO solutions will be used to make pulp and then measure the water content of palm fiber. Next, air dry it, then cook the palm fiber using a rotary digester machine for 2+2 hours at a temperature of 170°C to become pulp. The pulping process is basically the process of separating fiber from raw materials containing fiber by mechanical, chemical or a combination of both. The main purpose of pulping is to separate cellulose (fibers).

There are several methods for making pulp which is the process of separating cellulose from its binding compounds, especially lignin, namely mechanically, semichemically and chemically (Audina, 2015). In making this pulp, the author uses mechanical pulp making, namely using a rotary digester machine. Initially this process was developed by E.G. Kellen (Sulasmita, 2015). In this process, wood is crushed into mud.

After the palm fiber is removed from the machine, the fiber is then washed by filtering the pulp until the water resulting from the washing becomes clear. The water resulting from the palm fiber pulp filter is stored in a 25ml bottle for black liquor titration. This washing process is carried out to remove residual lignin and chemical solutions that stick to the pulp during the cooking process. Next, put it in a dryer to dry the pulp.

Table 1. Pulp Analyze

No	Parameter	Unit	Result	Test Method
1	Residual Alkali	%	7.712	In house method
2	Consume Alkali	%	15.036	In house method
3	Residual Alkali	%	0.964	In house method
4	Dry Basis Moisture Content	%	244.83	SNI 08-7070-2095
5	Wet Basis Moisture Content	%	71	SNI 0442
6	Yield Rate	%	38.425	In house method

7	Pulp Oven Dry Weight	gram	307.4	In house method
8	Water Requirements For The Formation Of Pulp Sheets	ml	9.560	SNI 08-7070
9	Pulp Requirements For 70 Sheets	Gram	525.5	In house method
10	Pulp Requirements For 10 Sheets	g/ml	4.322	In house method
11	Kappa Number	-	-	SNI 0494:2008

The process is carried out until the water content in it is reduced. Results of washing and drying palm fiber-based pulp. Analysis of cooked pulp is carried out by analyzing the water content contained in the pulp, the yield of the pulp produced and the kappa number in the pulp. The results of the analysis of palm fiber raw material pulp were carried out to determine the potential for utilizing palm fiber as an alternative to pulp from non-wood materials. The results of the pulp analysis are shown in Table 1.

The parameter of residual alkali in percent (%) was obtained as a result of 7.712% with the test method used, namely the in house method. The parameter of alkali consumption in percent (%) was obtained as a result of 15.036% with the test method used, namely the in house method. The residual alkali parameter in percent (%) was obtained as a result of 0.964% with the test method used, namely the in house method.

The 37 water content parameters on a dry basis with units of percent (%) obtained a result of 244.827586% with the method used, namely SNI 08-7070. The wet basis water content parameter in units (%) obtained a result of 71% with the test method used, SNI 0442. The yield content parameter in percent units (%) obtained a result of 38.425% with the test method used, namely the in house method. The oven pulp dry weight parameter in grams (g) was 307.4g with the test method used being SNI 08-7070.

The parameter for water requirements for the formation of pulp sheets in milliliters (ml) was obtained as a result of 9,560 ml with the test method used, namely the in house method. The parameter for pulp requirements for 70 sheets in grams (g) was 525.5 g with the test method used, namely the in house method. The parameter for pulp requirements for 10 sheets in g/ml units was 4.322 with the test method used being the in house method. No results were obtained for the kappa number parameter, because during the process of determining the kappa number the palm fiber did not show a color change to white when titrated with 0.1N sodium thiosulfate. Supposedly, palm fiber turns white when determining the kappa number to indicate how much lignin is left after the cooking process. So, it can be concluded that the remaining lignin in palm fiber pulp is so small that it cannot be read. The test method used for the kappa number is SNI 0494:2008.



Figure 2. SEM measurement results of palm fiber-based paper with 250x magnification

Testing of the morphological properties of palm fiber-based paper has been characterized using a Scanning Electron Microscope or SEM. SEM is a type of electron microscope that functions for morphological analysis or describing the surface of an object or material (Rahmayanti et al, 2018). Abdullah and Khairurrijal (2009) explain that SEM uses high-energy electrons which are fired at the surface of the material and the surface of the material hit by the high-energy electron beam will be reflected back, producing secondary electrons which go in all directions.

The printed palm fiber-based paper was observed using microscopic observation using SEM, starting with gluing the sample with a metal specimen holder stab. The sample is then put into a special room and then irradiated with a 10 kV powered electron beam so that the sample emits secondary electrons and bounced electrons which can be detected by the scientific detector which is then strengthened with an electrical circuit which causes a cathode ray tube (CRT) image to appear.

Photographing is done after selecting a certain part of the object (sample) and the desired magnification so that a good and clear photo is obtained. Analysis of the surface morphology of palm fiber-based paper at a magnification of 250 X is shown in Figure 2. The SEM analysis results clearly show that the fiber size of palm fiber-based paper is 20 μm (micrometers).

4. CONCLUSION

Based on the results of the research that has been carried out, several conclusions can be drawn, namely that pulp has been successfully made using palm tree fiber. Pulp is made by cooking by mixing ingredients such as 10% BaCl_2 solution; HCl 0.1 N; Ethanol 60%; PP (Phenolphthalein); Starch 1%; Sindur Methyl (SM), NaOH; Borax Solution; Technical Na_2S ; 1 N and 0.1 N THIO solution. Cooking into pulp is carried out for 2+2 hours at a temperature of 170°C using a rotary digester machine. After the cooking is complete, the cooked pulp is washed, dried by machine and then the pulp is printed into paper. Palm tree fiber-based paper fiber measuring 20 μm . These results were obtained from morphological measurements using a Scanning Electron Microscope with 250x magnification and a voltage of 10 kV.

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