Analysis of Cellulose Isolated from Sugar Bagasse: 
Optimization and Treatment Process Scheme 

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Abstract. PT. PG. Gorontalo is the largest sugar factory in Gorontalo province in which 10% of sugarcane waste is not utilized properly. In this study, the isolation and characterization of cellulose and α-cellulose from bagasse in the processing of alkali were 0.1M and 1.0M NaOH solution. The analysis method consisted of counterfeiting, dehemiselulose, delignification and bleaching of 10% H2O2 and 1% MgSO4. The next step was purification of cellulose to α-cellulose. Cellulose content was 75%, α-cellulose 37.89%. The characterization of the physico-chemical properties of the product included density analysis, viscosity, 2.01% moisture content, 5.01% ash content, pH 7.7 solubility test in 1M HCl, HNO3 1M, H2SO4 0.2M, Ba(OH)2 0.5M, KOH 0.5M, CH3COOH 1M, NaOH 2M, NH4OH 1M. The IR α-cellulose spectrum showed the presence of –OH group at wave number 3419, 3331, 3344, 3360 cm\(^{-1}\). The C=O bond at 1635 \(\text{cm}^{-1}\), 1642-1649 \(\text{cm}^{-1}\) showed different C=O stretch vibrations in cellulose I and cellulose II fibers and C-O bonds in 1161.83 and 1063-1065 \(\text{cm}^{-1}\), 995-895 \(\text{cm}^{-1}\) showed a change in the residual l about the glycosidic bond to Cellulose II which interprets α-cellulose. Morphological analysis used SEM while the degree of crystallinity used Diffractogram XRD.

1. Introduction
The development of agricultural waste-based adsorbents is one of the main objectives of green chemistry since it is economical, regenerative and it does not produce products that are supported and effective for adsorbing metals and dyes [1] as well as catalysts [2] and supercapacitor electrode materials. Organic waste is waste originated from living things that are easily decomposed. Inorganic waste is a waste that is difficult to be decomposes by decomposing microorganisms. According to the Gorontalo Province Agriculture Service, in 2017, rice husk waste production was ± 20% of the product [3]. For waste stems, leaves, shells and corn cobs, the amount was ± 35%, while ± 10% of sugarcane pulp waste from PT. Tolangohula Gorontalo Regency has not been used. Agricultural
wastes such as corn cobs [4] [5], rice husk [6], coffee pulp [7], kapok banana weed [8], banana heart [9], banana peels [10], cassava pulp [11], seeds coffee [12], durian seeds [13], water hyacinth [14], areca nut [15], and tea leaf pulp [16] are sources of alternative ingredients for the production of adsorbents to adsorb metals and synthetic dyes.

Sugarcane pulp is one of the agricultural wastes which contains high cellulose compounds 41.0 ± 0.1, hemicellulose 30.1 ± 0.7, lignin 21.2 ± 0.2 and silica / ash 0.7 ± 0.3 [17]. In natural: cellulose 39.37 hemicellulose 27.39 ± 4.05 and lignin 22.42%. In cellulose pulp: 72.56% cellulose, 18.77% lignin, 5.62% ashes. Before treated with Na₂S and Na₂SO₃, cellulose levels 41.29 ± 1.41, lignin 18.30 ± 0.78, hemicelluloses 33.18 ± 1.03, extraactives 7.65 ± 0.61. After being treated, it showed a decrease in levels of 20.21% -60.38% [18]. Determination of the composition of the lignocellulose substrate is an important step to determine the efficiency of the entire process designed to isolate the cellulose active compound. Several cellulose extraction methods have been developed to separate cellulose from lignin or other compounds. The chemical stages carried out were dewaxing, bleaching, dehemiselulose, delignification and purification. The presence of lignin would block cellulose in the ion transfer process, so that the adsorption process would be disrupted. Besides lignin, hemicellulose was also bound to fiber as an adhesive and accelerates the formation of fibers. The loss of hemicellulose resulted in a hole between the fibrils and a reduced bond between fibers [19]. Three stages were used to isolate cellulose namely (1) hot water at 70°C to remove hemicellulose (2) 15% NaOH solution at 98°C to remove lignin (3) bleaching stage [20]. Sugarcane pulp modified with propionic acid had a good adsorption capacity for methylene blue and orange II [21]. The use of NaOCl₂ solvents was an effective solvent for cellulose isolation rather than H₂O₂ and HCl [22]. Activation of H₃PO₄ 0.1N temperature 150°C for 24 hours in batches for pH, concentration, temperature and mass of the adsorbent has Cu adsorption capacity of 4.75 mg/g = 93% at pH 5 = 100 ppm [23], 1% (b/v) H₃SO₄ was used in a ratio of 1:10 solid - liquid temperature of 121°C for 20 minutes, delignification of 1.5% b / v NaOH ratio of 1:20 solid-liquid temperature 100°C for 1 hour in 50L [18]. Cellulose was isolated with 5 methods of mercerization using 0.7% sodium chloride and 4% sodium hypochlorite in acetic acid produced crytanillin index (%) 68% and crystallite size (nm) 5.2 ± 2.1 for method I [M1], [M2] = 70 [M3 ] = 67 [M4] = 72 [M5] = 73 and crystallite size (nm) 5.0 ± 1.5 [M2], 3.9 ± 0.4 [M3] 3.8 ± 1.2 [M4] and 4.0 ± 2.2 [M5]. 4% sodium hypochlorite acidified with pH 4 acetate was very effective having thermal stability, size and crystal properties and was ideal as a filler in polymer composites [24].

Cellulose is one of the main components of plant cell walls, especially the secondary cell walls that are most important for structural strength. Cellulose is a linear D-glucose polymer with β- (1,4) bonds. Cellulose forms a fiber component of plant cell walls. Cellulose is a compound that has a hydrophilic character and has primary and secondary alcohol groups which are both capable of reacting with reactive dyes. Cellulose with OH active groups on C2, C3, C6 atoms, which has the potential as a Chelating Agent (CAT) binding agent because it has a hydrophilic character with OH groups in each polymer unit and can interact physically and chemically, potentially in the dye adsorption mechanism synthetic [25]. Cellulose-based materials are often used in various research because they have good mechanical properties, such as high tensile strength and modulus, high purity, high water binding capacity and good network structure. Lignocellulosic biomass is all plants including agriculture and residues, wood and residues consisting of cellulose, hemicellulose and lignin which form covalent bonds between molecules and van der waals bonds form complex structures that are resistant to enzymatic hydrolysis and insoluble in water [26]. Lignocellulose has a modifiable C-O, NH and OH active group forming a pore structure and high surface area to increase the bio adsorbent capability [27]. The resulting bio adsorbent is thermally stable and has high carbon content, low inorganic substances, a high surface area, porosity, surface reactivity and adsorption capacity [28].
2. Material and Methods

2.1. Materials
Bagasse was from PT. PG. Gorontalo sugar factory, Gorontalo Province, Indonesia. The reagents were analytical grades; NaOH (reagent grade, 98%), HCl (ACS reagent, 37%), H₂O₂ (technical grade) were supplied by Sigma-Aldrich, and K₂Cr₂O₇, H₂SO₄, Avicel 102 (technical grade) a commercial brand of MCC, Ethanol (95% pa), Tholuena (95% pa) and distilled water were used as solvent. NaOH 0,1 M, EDTA 1000 ppm, H₂SO₄ 3%, H₂O₂ 2%. NaOH 17,5%, H₂SO₄ 0,1 N, H₂SO₄ 72%. The instrument used was shaker Digital ASTM E11 180 micron, pH meter, SEM, FT-IR and XRD.

2.1. Methods
2.2.1 Location Survey and Sampling
The location survey was conducted by coordinating with the PT. PG. Gorontalo sugar factory, and the sampling stage was carried out by doing sampling of bagasse waste as the ± 50 kg sugar cane milling. The result of this stage was bagasse waste with various sizes of particle powder brought by the laboratory for further research treatment.

2.2.2 Preparation of Sample
The samples were separated according to the size of the coarse-grained, then washed with water repeatedly until clean considering the sample which was very dirty mixed with soil/ muddy. Then it was rinsed with distilled water and dried for ± 1 week, then being heated at 60°C-70°C for 12 hours. Next the sample was blended until smooth, manually sifted then digitally dug to get bagasse powder with 80 mesh particle size. Bagasse powder produced with 80 mesh particle size was ready to be used for the next research phase.

2.2.3 Dewaxing Stage
The dewaxing phase was carried out by weighing 40 g of bagasse extracted by Soxhlet extractor using 400 ml of ethanol: toluene (1:2) solvent for 8 hours [29]. The solids extracted were separated from the filtrate and aerated in the air to evaporate the solvent for 2x24 hours. Next, the precipitate was washed with hot distilled water to remove the remaining organic solvents to neutral pH, and dried in an oven at 70°C and weighed constantly.

2.2.4 Dehemiselulose Stage
The dehemiselulose stage was carried out by 40 grams of bagasse powder (samples that did not go through the dewaxing stage) and bagasse powder from Dewaxing (samples through the dewaxing stage) were activated using 0.1 M NaOH solution with a ratio of 1: 10 added EDTA 1000 ppm 20 solution mL. The sample was put in a 3000 mL container and heated in an oven 60 - 70°C for ± 4 hours until all samples were extracted perfectly in the solvent. Then filtering and washing the sediment with aqueduct until neutral pH and dried in an oven temperature of 60 - 70°C for 12 hours and weighed constant were conducted.
2.2.5 Delignification Stage
The delignification process was carried out by means of the results of the alkali base activation phase being heated using 3% H₂SO₄ at 100°C for 2 hours, and then filtered. Furthermore, the residue from the filtering was washed using aquadest to pH neutral. Furthermore the neutral residue was heated using an oven at a temperature of 60°C - 70°C for 24 hours and weighed constantly.

2.2.6 Bleaching Stage
The bleaching stage was conducted by delignifying the sample results using 10% H₂O₂ and 1% MgSO₄ at 90°C for 2 hours, which was then filtered. The filtered residue was washed using an aquadest to a neutral pH and in the oven at 60°C - 70°C for 24 hours and weighed constantly.

2.2.7 Purification and Determination of Alpha Cellulose Stage
Determination of cellulose content used the Chesson method and alpha cellulose content used titrimetric analysis in 0.1 N ferro ammonium sulfate. The purification stage was carried out using 17.5% NaOH at 80°C for 30 minutes. Screening and residues were washed with distilled water until neutral pH and were heated at 60°C - 70°C for 24 hours. Residue weighing was carried out as alpha cellulose powder. The following is the working procedures for isolating cellulose and alpha-cellulose from bagasse waste according to Figures 2 and 3:

\[
\text{Yield (wt\%)} = \frac{\text{weight of activated carbon}}{\text{weight of raw material}} \times 100\% \tag{1}
\]
2.2.8 Stage of Characterization of Physico-Chemical Properties

2.2.8.1 Water Content

Water content analysis was done by drying clean petri dishes into an oven at 100°C for 30 minutes, then it was cooled using a desiccator for 20 minutes and weighed until it gained a constant weight. The next step was weighing 1 gram of alpha cellulose powder and putting it in a petri dish that has been weighted, then heating it in an oven at 110°C for 3 hours until it reached constant weight and coldness with the desiccator for 20 minutes and then it was weighed again. Analysis was done in duplicate. Calculating the water content used equation 2:

\[
\text{Water content (\%) } = \frac{a-b}{c} \times 100\%
\]

With: 
- \(a\) = sample weight and petri dish before drying (g)
- \(b\) = sample weight and petri dish after drying (g)
- \(c\) = sample weight before drying (g)

2.2.8.2 Ash Content

Analysis of ash content was done by heating clean petri dishes using an oven at a temperature of 100°C for 30 minutes, then cooling with a desiccator for 20 minutes and weighing until a constant weight was obtained. It continued by weighing 1 gram of alpha cellulose powder, putting it in a petri dish, and then putting it in a muffle furnace at 500°C for 3 hours until white ash was obtained. After that it was cooled by using a desiccator and weighed. Analysis was done in duplicate. Calculating the ash content used equation 3:

\[
\text{Ash content (\%) } = \frac{a-b}{c} \times 100\%
\]

With: 
- \(a\) = sample weight and petri dish before drying (g)
- \(b\) = sample weight and petri dish after drying (g)
- \(c\) = sample weight before drying (g)

2.2.8.3 pH Measurement

The pH test was carried out by dissolving the cellulose from the isolates into the distilled water which then entered the pH using a pH meter.

2.2.8.4 Viscosity Measurement

Viscosity measurements were carried out by weighing 0.25 g of dry pulp taken in a beaker. Next was adding EDTA 1%: 1% CuSO4 with a ratio of 3: 2, and the mixture was stirred at 30. The slurry was set at room temperature for 30 minutes. Filtration was measured by a viscometer instrument.

2.2.8.5 Fourier Transform Infrared (FTIR)

FT-IR spectroscopy analysis was used to determine the cellulose microcrystalline functional group using (Shimadzu IR-Prestige21, Institmen Laboratories Brawijaya University, Malang). Bands were recorded in the region from 4000 to 500 cm\(^{-1}\).

2.2.8.6 X-ray Diffraction (XRD)

Morphological changes in the crystalline structur of MCC fiber were analyzed using a high-resolution X-ray diffractometer (Analytical, X’Pert HighScore, at Geologi Laboratories, Bandung). The crystallinity of MCC fiber was determined from X-ray diffraction curves based on the Segal Method [Segal et al, 1959] in [Kyoung-Hwa Choi, et al, 2016]. Crystallinity index (CI) was calculated based on Equation 4:

\[
\text{CI (\%) } = \frac{I_{\text{cc}} - I_{\text{am}}}{I_{\text{cc}}} \times 100\%
\]
were $I_{202}$ is the peak height at 19.8-22.4 (20) and $I_{Am}$ is the peak height of amorphous cellulose to (11.9 - 19.50 20).

2.2.8.7 Morphological Characteristic
SEM was used to examine the microscopic structure and the surface morphology of MCC fiber. The instrument used was SEM-EDS JEOL JSM-6360LA, Japan, at Geologi Laboratories, Bandung.

3. Results and Discussion
3.1. Isolation of Cellulose and Alpha-cellulose
In the process of isolating sugarcane pulp cellulose, 2 treatments were carried out; the sample that went through the dewaxing stage and the one that did not. The aim is to see whether the dewaxing stage affects the nature of the physico-chemical characterization of the product because the dewaxing process aims to eliminate oil/wax and extractive compounds [29], coloring agents, tannins and other organic substances [30] which is feared to hinder contact between metals and coloring agents with the adsorbent. Lignocellulose waste is a mixture of fat, but the fat not only contains fat but also contains the wax/fat complex (phospholipid) which is nonpolar [31]. The series of sugarcane pulp sample treatment procedures is shown in Figure 4.

![Figure 4. Bagasse Sample Treatment](image)

The dewaxing phase used soclets which extracted a compound in an organic solvent continuously [32]. Used toluene - ethanol (2:1) in a mixed 400 ml. Dewaxing with reflux soclet acetone-ethanol (2:1) at 63°C was conducted to remove wax and extractive compounds. N-hexane: ethanol (2: 1) solvent showed hemicellulose content of 16.40%, cellulose 30.62%, lignin 29.96%, and silica 20.89%. The next was using ethanol-toluene (1: 2) temperature 85°C for 4 hours using the soxhlet method [5]. This stage aims to prevent the formation of condensation results with lignin during the isolation process. The principle is to extract wax, fat, tannin and coloring agents. Extraction was stopped when all extracted wax compounds shown in the solvent color on the chiffon became clear. The dewaxing stage of bagasse samples is shown in Figure 5.

![Figure 5. (a). Dewatering Process, (b) Filtering Process and (c) Product Result](image)

The dehemiselulose stage is the phase of removal of hemicellulose compounds contained in bagasse. The treatment for samples through the dewaxing stage was carried out after the solvent removal process was allowed to stand for 2 days, then the sample was refluxed for 60 minutes using 8% NaOH. Meanwhile, the treatment of samples without going through dewaxing was done using 0.1
M NaOH. The mechanism of the reaction that occurred during the dehemiselulose process is as follows according to the Figure 6.

![Figure 6. Mechanism Reaction on Cellulose and NaOH](image)

From the results of % yield, the dehemiselulose stage for the sample through the dewaxing stage was 47.80% while samples without dewaxing was 3.86%. As a result, it showed that the larger hemicellulose compounds were degraded in the sample through the dewaxing stage. Alkaline treatments were more effective to remove hemicellulose compared to acid treatment. Besides being able to degrade hemicellulose, treatment with alkaline can eliminate lignin. The alkali treatment produced cellulose 83.67±2.69, hemicellulose 13.97±1.67 and lignin 0.13±0.06 [34]. The dehemiselulose stage of bagasse samples is shown in Figure 7.

![Figure 7. (a). Dehemiselulose Process, (b) Filtering Process and (c)Product Result](image)

The purpose of delignification is to break the bonds and eliminate the content of lignin and hemicellulose contained in the sample of bagasse. At this stage, both samples which have gone through the dehemiselulose process were used. The sample was refluxed with 3% H₂SO₄ at 100°C for 150 minutes. The use of high temperatures would degrade lignin, but the remaining delignificator would integrate cellulose and possibly even more cellulose to be degraded. While at low temperatures, it would cause lignin not to decompose and still protect cellulose. This has the advantage that glucose is not hydrolyzed but cellulose is difficult to obtain [35]. The time used was the optimum time in delignification [36]. Then, the sample is washed with aquadest to neutral which goal was to remove lignin dissolved in acid. The delignification stage with the reflux method is shown in Figure 8.
Bleaching stage is a process that is carried out to degrade the remaining lignin that is still present in the sample, causing color changes and increasing cellulose purity. The sample was refluxed with 3% H$_2$O$_2$ at 90°C for 120 minutes. In the bleaching process, H$_2$O$_2$ solvents were used as oxidizing agents to degrade lignin. Besides, H$_2$O$_2$ is more environmentally friendly than other chemicals and its oxidizing power can be adjusted as needed by adding NaOH [37]. The use of H$_2$O$_2$ utilized its decomposition reaction, which produced oxygen and heat, oxidized the lignin that caused dark colors in the sample, becoming oxidized lignin that did not absorb light. During the peroxide fading process, lignin and cellulose only experienced a slight decrease in number. The process in the bleaching stage is shown in Figure 9.

The following is the result of the yield results at the stage of cellulose isolation of bagasse samples through the dewaxing stage or not through the dewaxing stage shown in table 1:

| Table 1. Percent of Yield |
|---------------------------|
| Treatment Analysis       | Treatment of Samples without Dewaxing | Treatment of Samples with Dewaxing |
| Initial Sample Weight    | 40 grams                                 | 40 grams                               |
| % Yield                  | 0.31%                                    | 0.81%                                   |
| Dehemiselulose Stage     | 3.86%                                    | 47.80%                                  |
| Delignification Stage    | 43.11%                                   | 45.74%                                  |
| Bleaching Stage          | 11.04%                                   | 13.94%                                  |
| Cellulose                | 75%                                      | 88%                                     |
| Alpha Cellulose          | 37.5%                                    | 45.2%                                   |
Based on the data in Table 1, there are differences in the yields of the results of sample treatments either through the dewaxing stage or not. The results of % yield produced in the sample that went through the dewaxing stage was greater than the sample without the dewaxing stage which was 45.74%. Meanwhile, the sample that went through the dewaxing stage was 43.11%. Therefore, it can be seen that lignin was more degraded in samples that went through the dewaxing stage. Cellulose content was higher when three-stage delignification, namely HNO₃ 2N NaOH and 10% H₂O₂ were at 80°C for 5 hours [38]. The yield of % yield produced in the sample through the dewaxing stage was 13.94%, while for the sample without passing the dewaxing stage was 11.04%, so that it could be seen that the lignin oxidation power was greater in the sample passing through the dewaxing stage. Determination of cellulose content using the Chesson method showed that samples went through the dewaxing stage were 88%, while samples without going through the dewaxing stage were 75%. Furthermore, the determination of alpha cellulose levels was carried out using the titrimetry method as cellulose purification. The results of alpha cellulose levels in the sample through the dewaxing stage were equal to 45.2%, while for the samples without going through the dewaxing stage were 37.5%. From the findings, it was concluded that cellulose that went through the dewaxing stage had undergone a process of removing compounds - extraactive compounds in the form of waxes, tannins, coloring agents contained in bagasse. Alpha Cellulose results as shown in the Figure 10.

![Figure 10](image)

**Figure 10.** (a). Alpha Cellulose without Dewaxing and (b) Alpha Cellulose with Dewaxing

### 3.2. The Stage of Characterization of Physico-Chemical Properties

Cellulose characterization was carried out by pH testing, determination of water content and ash content, viscosity, determination of cellulose and alpha cellulose levels, as well as SEM and FTIR analysis. The pH test aims to express the acidity or basicity of the cellulose product produced, through the dewaxing stage of 7.7 and which does not go through the dewaxing stage of 8.0. Solubility test was carried out by dissolving the sample in 1M HCl, HNO₃ 1M, 0.2M H₂SO₄, Ba(OH)₂ 0.5M, KOH 0.5M, 1M CH₃COOH, 2M NaOH, 1M NH₄OH, aquadest and hot aquadest. Basically, cellulose has properties that are insoluble in water, acidic solutions, aqueous alkalises or organic solvents such as benzene, alcohol, ether and chloroform. The results of the analysis showed that the cellulose products produced had solubility characteristics that were in accordance with the properties of cellulose compounds that were insoluble, even at high temperatures. Therefore, it can be seen that the resulting cellulose products can withstand extreme conditions at once. Solubility test data is shown in table 2 and characteristic data are in table 3:
Table 2. Solubility Test Result

| Solution Kind | Treatment | Alpha Cellulose without Dewaxing | Alpha Cellulose with Dewaxing |
|---------------|-----------|----------------------------------|------------------------------|
| HCl 1M        | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| HNO₃ 1M,      | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| H₂SO₄ 0.2M    | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| Ba(OH)₂ 0.5M, | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| KOH 0.5M      | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| CH₃COOH 1M    | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| NaOH 2M       | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| NH₄OH 1M,     | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| Cold Aquadest | Not Dissolved | Not Dissolved                     | Not Dissolved                 |
| Hot Aquadest  | Not Dissolved | Not Dissolved                     | Not Dissolved                 |

Table 3. The Results of Alpha-Cellulose Characterization

| Solution Kind | Treatment | Alpha Cellulose without Dewaxing | Alpha Cellulose without Dewaxing |
|---------------|-----------|----------------------------------|------------------------------|
| pH            | 7.7       | 8.0                              |                              |
| Water Content (%) | 2.0%      | 1.8%                             |                              |
| Ash Content (%)     | 5.0%      | 4.6%                             |                              |
| Viscosity       | 110 cp    | 86 cp                            |                              |
| Cellulose (%)    | 75%       | 88.4%                            |                              |
| Alpha-cellulose (%) | 37.89     | 45.2%                            |                              |

3.3. Interpretation of FTIR Data

Figure 11. FTIR Data
The IR spectrum shows that there is a widening uptake with a strong intensity in the area of around 3380.98 cm\(^{-1}\). This shows the presence of hydroxy groups (\(-\text{OH}\)). In addition, the absorption peak at 2902.67 cm\(^{-1}\) and 2900.74 cm\(^{-1}\) shows a stretch of C-H group bonds. Meanwhile, the peaks that occur around 1639.38 cm\(^{-1}\) and 1637.45 cm\(^{-1}\) indicate the absorption of C=C bonds found in lignin because the treatment given is not effective for removing lignin [39]. At absorption peak 1429.15 cm\(^{-1}\), it shows the presence of symmetrical CH\(_2\) buckling vibration groups [40] and 900.7 cm\(^{-1}\) absorption peaks and 896.84 cm\(^{-1}\) shows C-O-C sap which indicate the absorption characteristics of β-glycosidic. This bond connects glucose units to one another [32]. The results of the spectra describing the chemical treatment remove most of the lignin and hemicellulose [33].

3.4 Interpretation of XRD

![Figure 12. XRD Data from Alpha-Cellulose without Dewaxing](image)

![Figure 13. XRD Data from Alpha-Cellulose with/ Dewaxing](image)

From the results of XRD analysis for both products, it can be seen that cellulose is a powder composed of two phases, amorphous and crystalline phases with high purity and crystallinity. However, there are very noticeable differences between the two XRD analysis results because the XRD analysis results for alpha cellulose products which were processed without dewaxing stage has only one sharp peak with high intensity. Whereas for alpha cellulose products which went through the dewaxing stage has two sharp peaks. Consequently, it can be seen that from the two XRD analysis results cellulose products that went through dewaxing stage have a higher degree of crystallinity alpha, compared to products without dewaxing. It is obvious since the more and higher the intensity and the
narrower the half-peak width (FWHM) obtained, the higher the crystallinity of a compound. Using equation 4, the results of the crystallinity degree for alpha cellulose products without dewaxing were obtained by 82.8%, while alpha cellulose products through dewaxing drunkenness was 98.5%.

3.5 Interpretation of SEM

![Figure 14](image1.png)

**Figure 14.** (a). Morphology Alpha-Cellulose without Dewaxing and (b) Morphology Alpha-Cellulose with Dewaxing

From the results of SEM instrument interpretation, the surface morphology of the two alpha cellulose products is very different in which alpha cellulose products through dewaxing are more similar to the surface morphology of pure cellulose alpha as found in Figure 15 compared to alpha cellulose without dewaxing. Therefore, the surface morphology produces the better quality of alpha cellulose shown by alpha cellulose products through dewaxing.

![Figure 15](image2.png)

**Figure 15.** Pure Alpha-Cellulose

4. Conclusion

From the results of the study, it can be concluded that cellulose can be isolated from bagasse waste, through the dewaxing stage, dehemiselulose stage, delignification stage, and bleaching stage. In this study, a comparison of 2 sugarcane pulp samples was optimized through the dewaxing stage, which cellulose isolates that went through the dewaxing stage had a greater percent yield compared to the isolates without going through the dewaxing stage, as well as the results of characterization of the physico-chemical properties of the two samples. The results of the cellulose and alpha cellulose content contained in each isolate were different; cellulose through dewaxing had 88% cellulose
content and α-cellulose content of 48.2% while cellulose without dewaxing had a cellulose content of 75% and α-cellulose content of 37.8%. Based on the findings, of the two alpha cellulose products produced, the products that showed the best results were alpha cellulose which went through the dewaxing stage.

References
[1] Harimu L, Rudi L, Haetami A and Santos G A P 2019 Indo. J. Chem. Res. 6 L81-87
[2] Yusuf S, Dewi SH, Ridwan R and Wardiyati S 2018 Indones J Mater Sci. 14 L277-283
[3] Haryadi R and Dewanti R 2011 Produksi Pangan yang Aman (Jakarta: Dian Rakyat)
[4] Mantong J O, Argo B D and Susilo B 2019 J Keteknikan Pertan Trop dan Biosist. 6 L100-106.
[5] Kunusa W R, Isa I, Laliyo LA and Iyabu H 2018 J Phys. 1028
[6] Suprihatin S, Setiawan F A and Cahya R D 2019 J Tek Kim. 13
[7] Moelyaningrum AD 2019 Pemanfaatan Arang Aktif Ampas Kopi sebagai Adsorben Kadmium pada Air Sumur
[8] Hafni M S, Zilfa and Suhaili R 2015 J Chem Pharm Res. 7 L135–138
[9] Herawati D, Santos G S D and Amalina I 2018 J Sains Heal. 2 L1-7
[10] Ali A and Saeed K 2015 Desalin Water Treat. 53 L3586–3591
[11] Wahyuningsih A W K, Ulfin I and Suprapto S 2019 J Sains dan Seni ITS 7 L17-19
[12] Cerino-Córdova F J et al 2013 Int. J. Environ. Sci. Technol 10 L611–622
[13] Lestari I et al 2015 J of Chem and Pharmaceutical Res 7 L111–122
[14] Komala I 2019 Brilian: J Riset dan Konseptual 4 L5-15
[15] Syam A M 2019 J Rekayasa Kim & Lingkungan 14
[16] Nurafriyanti, Prihatin N S and Syaquia I 2017 Jukung: J Teknik Lingkungan 3 L56–65
[17] Yong T L K and Matsumura Y 2012 Ind. Eng. Chem. Res. 51 L11975-11988
[18] Dussán K J, Justo O R, Perez V H, David G F, Junior E G S and da Silva S S 2019 BioEnergy Res 12 L338-346
[19] Ghunam and Wayan I B 2011 J Biologi 10 L29 –33
[20] Moubark A, Grimi, Nabil B, Pizzi N and Antonio 2013 Ind. Crops Prod. 45 L296–302
[21] Said A E A A, Aly A A, Goda M N, El-Aal M A and Abdelazim M 2018 J of Polymers and the Environment 26 L242-2433
[22] Sepevani A A, Burhani D and Sudiyarmanto S 2018 J kim dan kemasan 40 L71-78
[23] Swathanthra P A and Rao V B 2015 Chem and Bioprocess Engineering: Trends and Developments L321-329
[24] Mzimela ZNT, Lингaniso LЗ, Revaprasadu N and Motaung TE 2018 Comparison of Cellulose Extraction from Sugarcane Bagasse Through Alkali. Materials Res 21
[25] Hidayat P 2008 Teknoin 13 L31-35
[26] Ioannidou O and Zabaniotou A 2007 Renew. Sust. Energ. Rev. 11 L1966-2005
[27] Sarker T C, Azam S M G G, El-Gawad A M A, Gablione S A and Bonanomi G 2017 Clean Technologies and Environmental Policy 19 L2343-2362
[28] Kyzas Z G and Bikiaris N D 2015 Mar. Drugs. 13 L312-337
[29] Utomo S B 2009 Aplikasi Lignoselulosa Sulfonat Ampas Tebu untuk Adsorbsi Zat Warna Tekstil Kationik Basic Violet 10 L523–538
[30] Sjostrom E 1995 Kimia Kayu, Dasar-dasar dan Penggunaan Edisi Kedua (Yogyakarta: Gadjah Mada University Press)
[31] Meyer L H 1982 Food Chemistry (California: The AVI Publishing Company Inc. Westport)
[32] Syahrani F P, Ernawati E E, Solihudin H and Tjokronegoro R A 2016 Pembuatan Komposit Selulosa Asetat-Silikat Sekam Padi PSN MIPA
[33] Khenblouche A, Bechki D, Gouamid M, Charradi K, Segni L, Hadjadj M and Boughali S 2019 Polímeros 29
[34] Xie J, Hse C Y, Cornelis F, Hu T, Qi J and Shupe T F 2016 Carbohydrate polymers 151 L725-734

[35] Permatasari H R, Gulo F and Lesmini B 2015 Pengaruh Konsentrasi H₂O₂ dan NaOH Terhadap Delignifikasi Serbuk Bambu (Gigantochloa Apus) L131–140

[36] Osvaldo Z S S P P and Faizal M 2012 Teknik Kimia 18

[37] Harpendi R, Padil P and Yelmida Y 2014 Jurnal Online Mahasiswa (JOM) Bidang Teknik dan Sains 1 L1-8

[38] Supranto A, Tawfiequrrahman D E, Yunanto 2015 J of Engineering Sci and Technology L35 – 46

[39] Pradana M A, Ardhyananta H and Farid M 2017 J Teknik ITS 6 L413-416

[40] Ratnayani O 2016 Ekstraksi Selulosa dari Sabut Kelapa (Bali: Universitas Udayana)