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Isolation and Characterization of Cellulose from Sugar Palm Pulp Using the Alkaline Method

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Abstract. *Sugar palm pulp is a by-product generated during the palm starch filtration process and contains lignocellulosic components. These lignocellulosic components can be separated through a delignification process. One chemical method of delignification uses an alkaline solvent. This study aimed to determine the optimal concentration of sodium hydroxide (NaOH) for maximising cellulose yield from sugar palm pulp and to characterise the resulting cellulose. The research was conducted using a completely randomised design (CRD) with four treatments and four replications. The treatments consisted of varying NaOH concentrations: K1 (1% w/v), K2 (3% w/v), K3 (5% w/v), and K4 (7% w/v). Observations were made on yield, moisture content, ash content, pH, colour, and iodine test. Data were analysed using analysis of variance (ANOVA). If the calculated F-value was greater than or equal to the tabulated F-value, the treatment effect was considered significant, and the analysis proceeded with Duncan's multiple range test at the 5% significance level. The results showed that sodium hydroxide concentration significantly affected yield, moisture content, ash content, pH, and colour. The selected treatments (3% NaOH concentration) yielded cellulose with the following characteristics: yield of 34.07%, moisture content of 6.8%, ash content of 5.99%, pH of 8.68, and whiteness degree of 36.65%. The colour coordinates were L=37.27 (low brightness) a=0.62 (slight redness) b=1.74 (slight yellowness). The iodine test resulted in a brown colour, indicating a positive reaction for cellulose.*

Keywords: *sugar palm pulp; cellulose; palm starch pulp; delignification; sodium hydroxide.*

Type of the Paper: Regular Article.

1. Introduction

Sugar palm (*Arenga pinnata*) is a plantation crop with significant cultivation potential. It contributes to the economy (through products such as palm sugar and starch flour), renewable energy (bioethanol), and environmental sustainability (soil conservation) [1]. Sugar palm plants served as sap producers, a source of renewable energy (bioethanol), a carbohydrate source (starch), and an ingredient in food and beverages (palm fruit), thereby offering high economic value. Sugar palm is widely distributed throughout Indonesia, including Riau Province.

According to the Plantation Department [2], Riau Province has 85 hectares of sugar palm plantations, with a fruit productivity of 24 tons. These data indicate that sugar palm in Riau Province has substantial development potential. All parts of the sugar palm plant are utilisable, including the stem [3].

The stem comprises the bark and the pith. The pith is processed through filtration to yield

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palm starch, with sugar palm pulp generated as a by-product. The palm starch industry in Klaten Regency, Central Java, generates 659 tons of sugar palm pulp waste annually, equivalent to 2.19 tons per day [4]. This waste is typically discarded and left to accumulate on vacant land or riverbanks [5]. Sustainable management of sugar palm cultivation, therefore, requires not only a focus on the primary products but also a comprehensive strategy for handling the resulting waste.

Sugar palm pulp contains lignocellulosic components, comprising 60.61% cellulose, 15.74% hemicellulose, 14.21% lignin, 0.5689% reducing sugars, 7.87% moisture, and 1.00% other constituents [6]. This high cellulose content presents an opportunity to valorise this waste stream by extracting the cellulose. The cellulose content is higher than that of coconut dregs, which contain 47.18% cellulose [7].

Cellulose is a linear polysaccharide polymer with the formula $(C_6H_{10}O_5)_n$ a primary structural component of plant cell walls. Cellulose is the most widely utilised component of the lignocellulosic complex in plants, compared with hemicellulose and lignin [8]. Cellulose is characterised as a fibrous compound with high tensile strength, and it is insoluble in water and organic solvents [9]. Applications of cellulose in the non-food sector include paper pulp production [10], bioethanol [11], and bioplastic composites [8]. In plant cell walls, cellulose is closely associated with hemicellulose and lignin, forming a complex lignocellulosic matrix.

Separating cellulose from lignocellulosic materials requires several steps, including size reduction of the material, treatment under alkaline conditions, and a bleaching process [12]. Alkaline conditions are intended to remove lignin. The bleaching treatment aims to complete the removal of lignin and chromophoric groups, resulting in brighter cellulose [13].

The process used to separate cellulose from hemicellulose and lignin is delignification. Delignification can be achieved through various methods, including mechanical [14], kraft [15], acid [16], alkaline [17,18], deep eutectic solvent (DES) [19], alcohol [20] and organosolv treatments [21]. In addition, biological (enzymatic) treatments have been applied to softwood and hardwood [22], rice husks [23], date palm wastes [24], and for activating cellulose microcrystals [25]. Combined treatments can also be applied, such as the sequential use of acidic and alkaline solvents at low concentrations [26].

A common and effective method for delignification is alkaline treatment. Alkaline delignification employs an alkaline solution to cleave lignin bonds, thereby dissolving lignin and facilitating its separation from cellulose [27]. Sodium hydroxide (NaOH) is a commonly used alkaline solution for delignification of materials such as nut shells [28], ginger [29], tobacco stems [30], coconut coir [31], and wheat straw [32]. Sodium hydroxide solution is also employed as a soaking medium for cellulosic materials prior to their application in composite manufacturing. For instance, Radzi et al. [33] used a 6 wt% NaOH solution to treat natural fibres such as sugar palm, kenaf, and bamboo at room temperature for 3 hours as part of an alkali treatment process before incorporating them into hybrid composites. This treatment aims to remove non-cellulosic materials such as dirt, wax, pectin, and hemicellulose, thereby increasing adhesion between the fibre and resin matrix, which ultimately improves mechanical properties and reduces water absorption in the resulting hybrid composites.

The use of NaOH for cellulose extraction does not damage or degrade cellulose at concentrations below 17% [34]. Apart from solution concentration, the yield and characteristics of the resulting cellulose are influenced by various factors, including delignification time and temperature. NaOH is highly effective for cellulose extraction and is relatively inexpensive compared with other chemical reagents. NaOH is also capable of disrupting the lignin structure—both crystalline and amorphous regions—solubilising portions of the lignin and hemicellulose, and inducing swelling of the cellulose structure [35].

NaOH concentration affects cellulose yield but does not influence the inherent characteristics of the cellulose. However, the efficiency of cellulose separation depends on the source material, as it is related to polysaccharide bonding interactions, lignocellulosic composition, and the proportion of amorphous regions within the material [36]. Alkaline extraction using a NaOH promotes the breakdown of lignocellulosic components, yielding water-insoluble cellulose during the subsequent bleaching and washing processes [37].

In delignification research using NaOH, Yuliatun and Santoso [13] isolated cellulose from sugarcane bagasse with a 2% NaOH concentration, resulting in bright white cellulose with a yield of 40.7% and a viscosity of 28 cP. Furthermore Umaningrum et al. [38] isolated cellulose from rice straw using a 7% NaOH concentration, obtaining the highest cellulose yield of 33.63%. Using an excessively high concentration of NaOH can cause cellulose degradation [39]. To date, no research on isolating cellulose from sugar palm pulp has employed sodium hydroxide solutions. Therefore, this study was conducted to optimize the yield and characteristics of cellulose from sugar palm pulp using various concentrations of sodium hydroxide solution.

2. Materials and Methods

2.1 Materials

The material used were sugar palm pulp waste (obtained from the sago starch processing described by Rahmayuni et al. [40], Sodium Hydroxide (NaOH), Sodium Hypochlorite (NaOCl), iodine solution, and distilled water.

2.2 Experimental Design

The study was conducted experimentally using a completely randomised design (CRD) with four treatments and four replications resulting in 16 experimental units. The treatments, based on

Umaningrum et al. [38], were as follows:

K1 = 1% (w/v) NaOH

K2 = 3% (w/v) NaOH

K3 = 5% (w/v) NaOH

K4 = 7% (w/v) NaOH

2.3 Cellulose Isolation Procedure

The sugar palm pulp was first sun-dried until its moisture content fell below 10%. Cellulose isolation from sugar palm pulp was performed following the method of Yuliatun and Santoso [13] with modifications. The isolation process began by weighing 20 g of sugar palm pulp powder and placing it in an Erlenmeyer flask. Subsequently, 150 mL of NaOH solution (1%, 3%, 5%, or 7%, w/v) was added to the flask. The mixture was then heated at 80℃ for 2.5 hours. After heating, the mixture was filtered through a filter cloth, and the solid residue was washed with distilled water until it was no longer sticky. The solid residue was then mixed with a 5% (v/v) NaOCl solution for bleaching, and the mixture was heated at 80℃ for 4 hours. The mixture was then filtered through a filter cloth, and the solid residue was washed with distilled water until a bright colour was obtained. Finally, the solid cellulose residue was oven-dried at 50°C for 3 hours [41]. The resulting cellulose was then subjected to analysis.

2.4 Analytical Methods

Yield

Cellulose yield (%) was calculated as the mass of isolated cellulose divided by the initial mass of sugar palm pulp, multiplied by 100. The yield was calculated using the following Eq. 1.

$$\text{Yield (\%)} = \frac{\text{Mass of isolated cellulose (g)}}{\text{Initial mass of palm starch pulp (g)}} 100 \qquad (1)$$

Moisture Content

A 2 g sample was placed into a pre-weighed porcelain crucible. The crucible had been previously cleaned and dried in an oven at 105°C for 1 hour. The sample and crucible were dried in an oven at 105°C for 3 hours, then removed, cooled in a desiccator for 15 minutes, and weighed. The sample was heated at 105°C for 1 hour, then cooled in a desiccator and weighed. This cycle was repeated until a constant weight was achieved (i.e., a difference of less than 0.2 mg between successive weighings). Moisture content was calculated using the following Eq. 2.

$$\text{Water content (\%)} = \frac{\text{Initial weight (g)} - \text{Final weight (g)}}{\text{nitial weight (g)}} 100 \qquad (2)$$

Ash Content

Porcelain crucibles were first dried in an oven at 105°C for 1 hour. Then the empty crucible was then cooled in a desiccator for 15 minutes and weighed. A 2 g sample was placed into the pre-weighed crucible. The sample and crucible were placed in a furnace at 600°C for 2 hours, until whitish ash was obtained. After the furnace temperature had dropped to approximately 30–40°C, the crucible was removed using tongs, cooled in a desiccator for 30 minutes, and weighed. Ash content was calculated using the following Eq. 3.

$$\text{Ash content (\%)} = \frac{\text{Ash weight (g)}}{\text{Sample weight (g)}}\ 100\% \qquad (3)$$

pH

The pH was determined using a pH meter. Prior to measurement, the pH meter was calibrated using standard buffer solutions of pH 4.0 and 7.0. A 1 g sample was added to 5 mL of distilled water and stirred until homogeneous using a vortex mixer. The pH was then measured by immersing the electrode in the suspension and recording the value once a stable reading was achieved.

Colour and Whiteness

Colour was determined using the Hunter Lab colour system with a colorimeter. The colorimeter was first calibrated using the whiteness standard provided with the instrument. The sample was placed in the designated container, and measurement was initiated. The L*, a*, and b* values were recorded. The L* value represents lightness, ranging from 0 (black) to 100 (white). The a* value represents the position on the red-green axis, where positive values indicate redness (0 to +80) and negative values indicate greenness (0 to -80). The b* value represents the position on the yellow-blue axis, where positive values indicate yellowness (0 to +70) and negative values indicate blueness (0 to -70). The whiteness value was calculated using the following Eq. 4.

$$\text{Whiteness} = 100 - [(100 - L)2 + a2 + b2]1/2 \qquad (4)$$

Iodine test

A 0.1 g sample was placed in a small test tube, 1 mL of iodine solution was added, and the mixture was stirred using a vortex mixer. The colour change upon addition of iodine was observed. A brown colour change indicates a positive reaction for cellulose.

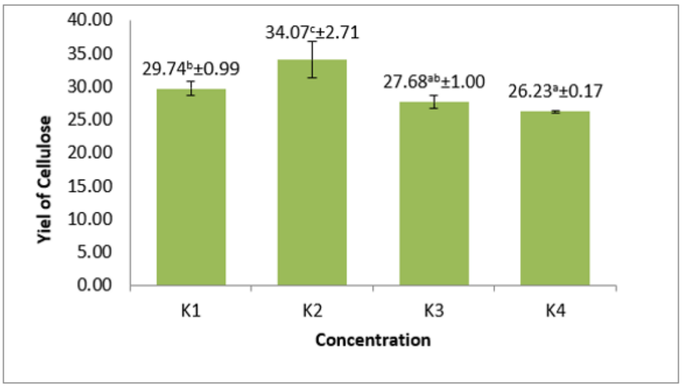
3. Results and Discussion

3.1 Cellulose Yield

Cellulose yield was calculated as the percentage ratio of the mass of cellulose obtained after delignification to the initial mass of the sugar palm pulp used. Analysis of variance (ANOVA) showed that NaOH concentration had a significant effect ($p < 0.05$) on the cellulose yield. The mean cellulose yield values are presented in Fig. 1.

The cellulose yield across all treatments ranged from 26.24% to 34.07% (Fig. 1). The highest yield (34.07%) was achieved with treatment K2 (3% NaOH), which was significantly different from the yields of K1, K3, and K4. The lowest yield (26.24%) was obtained with treatment K4

(7% NaOH), which was not significantly different from K3 but was significantly different from K1 and K2.



Note: Numbers followed by different lowercase letters are significantly different according to Duncan's multiple range test (DMRT) at the 5% level

Fig. 1. Mean cellulose yield from sugar palm pulp treated with different NaOH concentrations.

Fig. 1 shows that the cellulose yield increased with K2 but decreased with K3 and K4. Cellulose yield tended to decrease with increasing NaOH concentration beyond 3%. Increasing NaOH concentration enhances the solubility of lignocellulosic components [13].

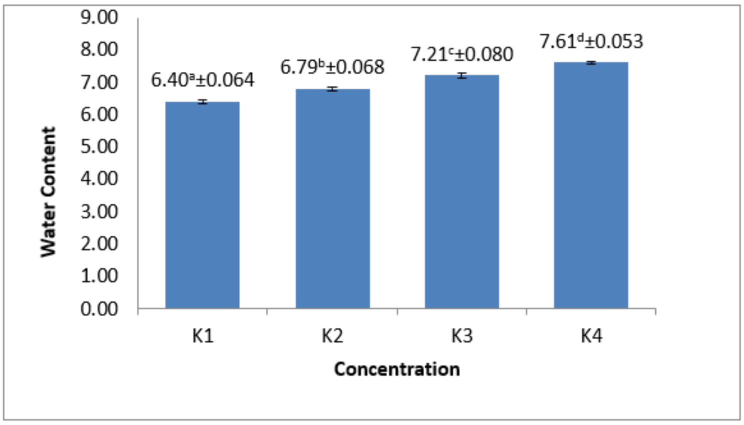
Higher NaOH concentrations dissolve lignin and hemicellulose more effectively; however, they also risk damaging the cellulose structure, potentially degrading cellulose into simpler compounds and reducing yield. Conversely, a concentration that is too low (e.g., 1% NaOH) may be insufficient to effectively dissolve hemicellulose and lignin. Under such conditions, some cellulose remains bound to lignin and hemicellulose, thereby reducing the final yield. An optimal NaOH concentration effectively removes lignin and hemicellulose while preserving the cellulose structure.

The average yield obtained in this study (34.07% at 3% NaOH) was higher than that reported by Umaningrum et al. [42] for cellulose isolated from rice straw using a similar concentration (21.77%). This difference is likely attributable to the varying cellulose content of the source materials. Rice straw has a cellulose content of 21.11% [43], whereas sugar palm pulp contains 26.53% cellulose [44].

The effectiveness of alkaline treatment observed here is consistent with findings by Ilyas et al. [45], who reported that alkali treatment significantly increased the cellulose content of sugar palm fibre. After acid treatment (sugar palm acid-treated fibres, SPATF), cellulose content increased to 56.67%. Following alkaline treatment with sodium hydroxide (sugar palm cellulose, SPC), cellulose content increased significantly to 82.33%. This underscores that alkaline treatment is more effective than acid treatment for the delignification of sugar palm biomass.

3.2 Moisture Content of Cellulose

Moisture content refers to the amount of water present in a material, expressed as a percentage. Analysis of variance showed that NaOH concentration had a significant effect on the moisture content of the isolated cellulose. The mean moisture content values are presented in Fig. 2.



Note: Numbers followed by different lowercase letters are significantly different according to Duncan's multiple range test (DMRT) at the 5% level

Fig. 2. Mean moisture content of cellulose from sugar palm pulp treated with different NaOH concentrations

The moisture content across all treatments ranged from 6.40% to 7.61% (Fig. 2). The lowest moisture content (6.40%) was obtained with treatment K1 (1% NaOH), which was significantly different from all other treatments. Fig. 2 shows that moisture content increased with increasing NaOH concentration. This is likely due to an increase in the surface area and porosity of cellulose following alkaline treatment, which enhances its water absorption capacity.

This trend is supported by Asmoro et al. [37], who attributed the increase in moisture content to the alkalisation reaction between NaOH and cellulose, which forms a cellulose-alkali complex and water, thereby enhancing the cellulose's capacity to absorb water.

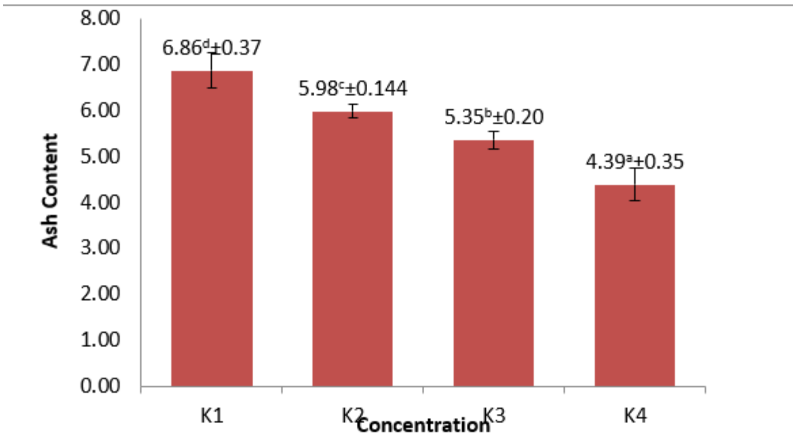
Alkaline treatment with NaOH can reduce cellulose crystallinity by disrupting hydrogen bonds within its crystalline structure. This leads to fibre swelling and an increase in the amorphous phase, which has a higher affinity for water molecules.

The moisture content of cellulose in this study increased with increasing NaOH concentration. This trend is consistent with the findings of Asmoro et al. [37], who also observed an increase in cellulose moisture content with higher NaOH concentrations. In their study, the lowest moisture content was obtained with the lowest NaOH concentration (10%), which aligns with our finding that the lowest moisture content occurred at the lowest NaOH concentration (1%).

This observed increase in moisture content with alkalinity is supported by Ilyas et al. [45], who reported a rise from 8.36% in raw sugar palm fibre to approximately 12.86% in cellulose nanofibrils. This increase is attributed to the surface structure of cellulose, which contains numerous hydrophilic hydroxyl (OH) groups that readily absorb water molecules. Furthermore, chemical and mechanical treatments open the fibre pores, causing expansion and separation, which increases volume and subsequently moisture content. However, this volume increase leads to a decrease in fibre density, as the mass decreases relative to the expanded volume.

3.3 Ash Content of Cellulose

Ash content represents the inorganic residue (minerals) remaining after the complete combustion of organic matter. Analysis of variance showed that NaOH concentration had a significant effect on the ash content of the isolated cellulose. The mean ash content values are presented in Fig. 3.



Note: Numbers followed by different lowercase letters are significantly different according to Duncan's multiple range test (DMRT) at the 5% level

Fig. 3. Mean ash content of cellulose from sugar palm pulp treated with different NaOH concentrations.

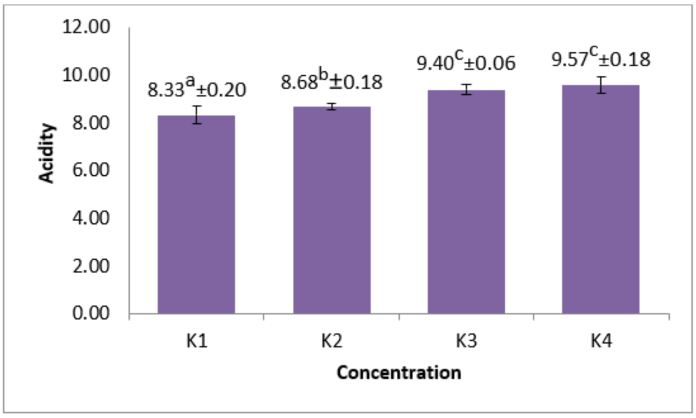
The ash content across all treatments ranged from 4.39% to 6.86% (Fig. 3). The The lowest ash content (4.39%) was obtained with treatment K4 (7% NaOH), which was significantly different from all other treatments. Fig. 3 shows that ash content decreased with increasing NaOH concentration. This decrease occurs because higher NaOH concentrations more effectively solubilise and remove inorganic minerals and other non-cellulosic components during the delignification and washing steps.

This finding aligns with Hutomo et al. [34], who reported that high concentrations of OH^- ions readily bind with metals, while Na^+ ions replace salt groups bound to acid groups, thereby solubilising salts.

In this study, cellulose ash content decreased with increasing NaOH concentration. This trend is consistent with Hutomo et al. [46], who also observed a decrease in ash content with increasing NaOH concentration. In their study, the lowest ash content was obtained with the highest NaOH concentration (20%), which aligns with our finding that the lowest ash content occurred at the highest NaOH concentration (7%).

3.4 pH of Cellulose

The pH of the extracted cellulose was measured in an aqueous suspension. The cellulose was thoroughly washed after delignification and bleaching. This was done to minimize any residual NaOH or NaOCl that could affect the pH measurement. Analysis of variance showed that NaOH concentration had a significant effect on the pH of the isolated cellulose. The mean pH values are presented in Fig. 4.



Note: Numbers followed by different lowercase letters are significantly different according to Duncan's multiple range test (DMRT) at the 5% level

Fig. 4. Mean pH of cellulose from sugar palm pulp treated with different NaOH concentrations.

The pH across all treatments ranged from 8.33 to 9.57 (Fig. 4). The lowest pH (8.33) was obtained with treatment K1 (1% NaOH), which was significantly different from all other treatments. The highest pH (9.57) was obtained with treatment K4 (7% NaOH), which was not significantly different from K3 but was significantly different from K1 and K2. Fig. 4 shows that pH increased with increasing NaOH concentration. The increase in pH with higher NaOH concentrations is expected, as a more concentrated alkali solution leaves behind more residual hydroxide ions (OH^-) even after washing. These ions reduce the concentration of hydrogen ions (H^+) in the suspension, resulting in a higher pH value.

In this study, cellulose pH increased with increasing NaOH concentration. This trend is consistent with Asmoro et al. [37], who also reported an increase in cellulose pH with higher NaOH concentrations. In their study, the lowest pH was obtained with the lowest NaOH concentration (10%), which aligns with our finding that the lowest pH occurred at the lowest NaOH concentration (1%).

3.5 Colour and Whiteness of Cellulose

The colour of the isolated cellulose was quantitatively assessed using a colorimeter. The L* value represents a brightness ranging from 0 (black) to 100 (white). The a* value represents the position on the red-green axis, where positive values indicate redness (0 to +80) and negative values indicate greenness (0 to -80). The b* value represents the position on the yellow-blue axis, where positive values indicate yellowness (0 to +70) and negative values indicate blueness (0 to -80) [47]. Analysis of variance showed that NaOH concentration had a significant effect on the whiteness of the isolated cellulose. The mean colour and whiteness values are presented in Table 1.

The whiteness values across all treatments ranged from 36.14 to 37.65 (Table 1). The highest whiteness (37.65) was obtained with treatment K1 (1% NaOH), which was significantly different from all other treatments. Table 1 shows that the L* (lightness) value decreased with increasing NaOH concentration. This is likely because more concentrated NaOH leads to greater lignin degradation, producing phenolic compounds that can darken the cellulose [13].

Table 1. Colour parameters and whiteness of cellulose from sugar palm pulp treated with different NaOH concentrations.

Treatment	Degrees of Whiteness	L*	a*	b*
K1 = 1% NaOH concentration (w/v)	37.65^{d} ± 0,06	37.67	0.53	1.34
K2 = 3% NaOH concentration (w/v)	37.25^{c} ± 0,06	37.27	0.62	1.74
K3 = 5% NaOH concentration (w/v)	36.81^{b} ± 0,10	36.85	0.73	2.13
K4 = 7% NaOH concentration (w/v)	36.14^{a} ± 0,07	36.20	0.88	2.55

Note: Numbers followed by different lowercase letters are significantly different according to Duncan's multiple range test (DMRT) at the 5% level

Increasing NaOH concentration enhances lignin degradation, breaking ether and ester bonds in lignin to produce phenolic compounds. Strong bases such as NaOH can open the aromatic rings in lignin converting them to phenol and other phenolic compounds. Thus, while more lignin is removed, the degradation by-products can re-adsorb onto the cellulose fibres, leading to a darker colour and a decrease in the L* (lightness) value.

These results are consistent with by Yuliatun dan Santoso [13], who reported a decrease in brightness of bagasse cellulose with increasing NaOH concentration. This issue can be addressed by increasing the concentration of the bleaching solution in parallel with the alkali concentration, as demonstrated by Thoriq et al. [48], who achieved increased brightness in oil palm empty fruit bunch fibres by optimising both NaOH and H_2O_2 concentrations. In the present study, the concentration of the NaOCl bleaching solution was fixed at 5% for all treatments, which may explain why the whiteness decreased with increasing NaOH concentration. Optimising the bleaching step for each NaOH concentration could potentially improve the final colour.

Andari et al. [49] used hydrogen peroxide for bleaching coconut fibre over 120 minutes, achieving a whiteness index of 76.23±1.54%. H_2O_2 has also been used to bleach palm trunk pulp pre-treated by wet disk milling to obtain nanofibrillated cellulose [50]. The choice of bleaching agent also influences the final whiteness. For instance, hydrogen peroxide (H_2O_2) is known to oxidise lignin effectively with less damage to cellulose compared with hypochlorite.

Table 2. Iodine test results for cellulose from sugar palm pulp treated with different NaOH concentrations.

Treatment	Colour
K1 = 1% NaOH concentration (w/v)	Brown
K2 = 3% NaOH concentration (w/v)	Brown
K3 = 5% NaOH concentration (w/v)	Brown
K4 = 7% NaOH concentration (w/v)	Brown

3.6 Iodine Test

The iodine test is a qualitative essay used to detect polysaccharides. The results showed that the iodine test on all cellulose samples resulted in a brown colour change, indicating a positive reaction for cellulose. The iodine test observations for each treatment are presented in Table 2.

Table 2 shows that all samples produced a brown colour upon addition of iodine, confirming the presence of cellulose. As noted by Desyanti [51], the iodine is used to identify polysaccharides. The test relies on the interaction of iodine with helical polysaccharide structures to form polyiodide chains. For instance, the amylose component of starch forms a helix that traps iodine, producing a characteristic blue-black colour. Cellulose, with its linear, non-helical structure, does not form this complex and typically shows no specific colour change or only a faint brownish tint from the iodine solution itself. The brown colour observed in all treatments is, therefore, consistent with the presence of cellulose.

The iodine test is a qualitative method for detecting cellulose. Nadhila [52] similarly used the iodine test for cellulose in areca nut skin, observing a brown precipitate indicative of cellulose.

4. Conclusions

The concentration of sodium hydroxide significantly affected the yield, moisture content, ash content, pH, and colour of the cellulose extracted from sugar palm pulp. The treatment using 3% NaOH (K2) was selected as the optimal condition, producing the highest cellulose yield (34.07%), along with a moisture content of 6.8%, ash content of 5.99%, pH of 8.68, and a whiteness degree of 36.65%. The resulting cellulose exhibited a relatively low degree of whiteness, indicating that further optimisation of the bleaching process is required.

Abbreviations

K1	Concetration NaOH1 1%
K2	Concentration NaOH 3%
K3	Concentration NaOH 5%
K4	Concentration NaOH 7%

Data Availability Statement

This research was conducted at the Agricultural Product Processing Laboratory and Agricultural Product Analysis Laboratory, Faculty of Agriculture, University of Riau, Pekanbaru. The research was conducted over three months, from May to July 2024. We are happy to provide information related to data acquisition for those who need it.

CRediT Authorship Contribution State

Yelmira Zafiatri: Responsible for the entire process including the formulation of scientific concepts and hypotheses, experimental design, variable determination, data integration, article creation (original and corresponding manuscripts). **Rahmayuni**, **Rahmadini Payla Juarsa**, **Yanti Nopiani**, **Ahmad Ibrahim**: Responsible for the implementation of the research and reviewing articles and journal grammar. **Dinda Yusra Danil**, **Siti Nuraisah**: Assisting in the implementation of the research, preparation of materials and analysis of samples and data.

Declaration of Competing Interest

The authors of this manuscript declare no conflict of interest or competing interest.

Declaration of Use of AI in the Writing Process

Nothing to disclose.

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