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Characterization of Cellulose Fiber Isolation From Kapok Randu (Ceiba pentandra) on NaOH Concentration and Delignification Process Time

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ABSTRACT

Kapok range is a natural fiber that has considerable potential in the form of cellulose and can be enhanced by its physical and mechanical value cellulose. This study aims to analyze the character of cellulose produced from kapok and isolation. The cellulose isolation method used a factorial complete randomized design, namely the first factor of NaOH concentration (4%, 6%, and 8%) and the second factor of extraction time (40, 50, and 60 minutes). The cellulose isolation process showed that the method did not significantly affect the yield of randu kapok cellulose. The highest yield and degree of whiteness resulted from the treatment of 4% NaOH concentration and 40 minutes of extraction time with a yield of 6.54 ± 0.82%. The following result showed that the treatment had a significant effect on the results of the degree of whiteness. The highest degree of whiteness resulted from the treatment of 8% NaOH concentration and 60 minute extraction time of 30 ± 0.7. The cellulose isolation results of kapok resulted in cellulose content of 90.15 ± 0.81%, hemicellulose content of 3.6 ± 0.52%, and lignin content of 0.91 ± 0.03%. The analyzed properties provide a strong basis for considering the potential use of such cellulose nanofibers in various industrial applications, such as the manufacture of sustainable composite materials or other value-added products.

INTRODUCTION

Sustainable industry has become an essential focus in today's economic development. One of the main aspects of sustainable industry is the development of environmentally friendly raw materials to reduce negative impacts on the environment and minimize dependence on limited resources. Sustainable raw materials that are environmentally friendly must meet criteria such as sufficient availability in the long term, can be sustainable in production and are easily decomposed naturally by microorganisms or biological processes. Raw materials that have great potential in the sustainable industry are cellulose (Mulyadi, 2019). Examples of raw materials that have high cellulose are nata de coco (Pertiwi et al., 2017), bamboo (Kusumaningrum et al., 2017), kapok range (Bhambure et al., 2022), and so on.

Kapok randu (Ceiba pentandra) is a tropical tree that grows in Indonesia and belongs to the order Malvales and the Malvanceae family. The number of products from kapok trees is often utilized and used directly without any prior processing, so its use still needs to be improved from economic value. Especially in the fruit pulp, kapok fibers contain about 65-67% cellulose from the total meat (Gea et a., 2023). The production of kapok randu in Indonesia has varied throughout its history. In 2021, BPS (Central Bureau of Statistics) recorded that the area of smallholder plantations for kapok randu commodities was around 26,588 hectares with a production of around 6,000 tons.

Kapok randu is a natural fiber obtained from the kapok randu plant. Kapok randu has long fibers, is lightweight, and has good insulation properties. Using cellulose nanofiber and kapok as raw materials for sustainable industries has excellent potential to reduce environmental impacts and support sustainable development. An in-depth characterization analysis is required to optimize the use of these two materials. This characterization includes understanding cellulose, kapok, nanofibers' structure, potential applications, and their physical properties (Pratama et al., 2019). This is because cellulose, which has strong mechanical properties, lightweight, and biodegradability, is an attractive raw material for various industrial applications.

Therefore, this research aims to characterize cellulose isolation from kapok randu. With an in-depth range of materials properties and potential applications, this research is expected to contribute to sustainable industries' development significantly. In addition, this research can also promote the use of environmentally friendly raw materials and minimize the impact of industry on the environment.

METHODS

Place and Time of Research

This research activity was conducted at the Integrated LAB of Universitas Nahdlatul

Ulama Indonesia Campus B, at Jl. Parung Hijau, Tegal Jampang Hambulu Village, Pd. Udik, Kec. Kemang, Bogor Regency, West Java. Testing was conducted at the ILAB of the National Research Agency Cibinong, West Java.

Research Materials and Tools

The raw material for making cellulose isolation in this study is kapok randu, and the chemicals used are H2O2, NaOH, and distilled water. The tools used in this research are a refrigerator, electric stove, oven, pH meter, and a set of glassware (2000 ml beaker, stirring rod, and thermometer).

Experimental Design

The experimental design applied in this study was a factorial complete randomized design (CRD) with two treatment variables with Robbani (2022) modified. The first variable was NaOH concentration, divided into three levels: 4%, 6%, and 8%. The second variable is the length of cellulose delignification extraction, which has three levels: 40 minutes, 50 minutes, and 60 minutes. All treatment combinations were repeated twice. If there is a significant effect between treatments, it will be continued with the Duncan test.

Research Stages

1. Raw material preparation

One hundred grams of kapok randu was measured before initiating the isolation process. Then, NaOH solution was prepared with concentrations ranging from 4% to 8%, while H2O2 solution was prepared with 20% concentration.

2. Randu kapok cellulose isolation

The cellulose isolation process is based on a specific method with some adjustments. Cellulose fibers were obtained by the first step, which was weighing 50 grams of kapok randu fiber, then putting it into a glass cup. Next, the kapok range was added to the NaOH solution with 4%, 6%, and 8% concentrations. This mixture was then heated on an electric stove with a temperature between 95 oC and 100 oC for 1 hour. After that, the fibers were washed with RO (reverse osmosis) water until they reached a neutral pH and then dried in an oven at 55 oC for 1 day.

The next step involved bleaching using 15% H2O2 at temperatures between 95 and 100 oC for 1.5 hours. After that, the fibers were filtered and washed with RO to reach pH 7 (neutral) so the cellulose appeared white. Furthermore, the yield was determined by the characterization of cellulose isolated from all treatments in the experimental design. Using the Van Soest Analysis method, the highest yield was analyzed for its fiber components, namely hemicellulose, lignin, and cellulose.

Testing phase

Analysis of range kapok cellulose yield

Calculating the yield of kapok randu cellulose is done after kapok randu is extracted

and has a neutral pH; then, kapok randu is baked using a temperature of 105 ºC for 24 hours to reduce the water content. The resulting yield is the percentage of the weight of cellulose obtained after the oven.

Water Content

Previously, provide a Petri dish and then heated using a temperature of 1050C, after which it is cooled in an applicator and then weighed in an empty state weighed a sample of 5 grams, then put in an oven at a temperature of 1050C using a time of 4 hours to 6 hours. After the oven, cellulose can be weighed.

Ash content

Provide an empty petri dish and then heat it using a temperature of 400-600 0C, after which it is cooled in an applicator, weighed in an empty state, and weighed a sample of 5 g. The sample is burned on a hot plate until it is not smoking using a time range of 3 hours, then put in a furnace, cooled in an applicator, and weighed.

Fiber content

The sample was weighed with a weight of 0.3 g, then put into a glass cup and then put into the heater extract tool. H2SO4 0.3N A total of 50 mL was heated for 30 minutes. Filter paper that has been heated in a 1050C oven for 1 hour and then weighed. Filtering was done with a suction flask connected to a vacuum pump, then washed successively using 50 mL hot water, 50 mL H2SO4 0.3N, and 25 mL acetone. The filter paper and its contents were put into a porcelain cup in a 105 0C oven for 1 hour. Next, remove and cool in an applicator, then weigh. The cup was put back into the furnace, lifted, and cooled.

Lignocellulose test

Determination of a material's cellulose, hemicellulose, and lignin content must first determine ADF and NDF levels. The procedure is as follows:

Acid Detergent Fiber (ADF) content

As much as 0.5 g was put into a glass cup and 50 ml ADS solution and 2 mL decalin were added. Heated for 1 hour on a water bath. After that, filtering was carried out using the help of a vacuum pump also by using a glass filter that was weighed. Washing was done using hexanes, acetone, and hot water. The results of the filtration were dried using an oven. After that, it was put back into the desiccator to cool down and then weighed.

Neutral Detergent Fiber (NDF) content

As much as 0.5 g was put into a glass cup measuring 2500 mL, then added with 50 mL NDS solution and 0.5g Na SO Heated for 1 hour. Next, the glass was weighed. After filtering with the help of a vacuum pump, the sample was rinsed with hot water and acetone. The filtering results were dried in a 105°C oven. After that, it was put again in an applicator for 1 hour, then the final weighing was carried out as NDF content.

Lignin and Cellulose Content

The ADF residue in the glass jar was placed on a tray containing approximately 1 cm of water. Then H: SO, 72% was added to 3⁄4 of the glass and left for 3 hours while stirring. Next, filtering was carried out with the help of a vacuum pump, and washing was carried out as in the previous analysis. Drying was carried out using a 105 ° C oven, then cooling in a desiccator and weighing as the final weight; if burned in a 500 ° C furnace, it cooled in a desiccator and stored again as the final weight.

RESULTS AND DISCUSSIONS

Effect of NaOH Concentration on Cellulose Yield of Kapok Randu

Cellulose is a polysaccharide as the main component in plant cell walls. Cellulose has a repetitive chemical structure that is strong and not easily damaged. Cellulose can be found in various plants, including cellulose in kapok randu. Cellulose has essential benefits in health, agriculture and industry. Cellulose from kapok randu is important to study because kapok randu is an abundant natural source of cellulose and has a reasonably high cellulose content, so it has potential as an industrial raw material. Research on randu kapok cellulose extraction can increase the added value of natural raw materials (randu kapok). This research can contribute to the sustainable utilization of natural resources and support industries made from natural raw materials that are environmentally friendly. In addition, research on cellulose is also essential to understand the morphology of kapok and fiber and its chemical properties that affect its usefulness in various fields of application (Sangalang., 2021).

The NaOH reaction mechanism in extracting kapok randu cellulose involves delignification, where NaOH plays a role in dissolving lignin, a non-cellulosic component of kapok randu. This process allows separation between cellulose and lignin so cellulose can be extracted efficiently. NaOH acts as a chemical bond-breaking agent between cellulose and lignin, allowing cellulose to be freed from other components and isolated better. Thus, the right NaOH concentration and extraction time are critical in cellulose extraction to ensure maximum efficiency and quality of extraction results (Dong et al., 2024).

According to Sopianoor et al. (2016), yield is generally the ratio between the output produced from raw materials and the input used in the processing process. The higher the yield, the higher the efficiency of raw material utilization. This study aims to determine the yield from the cellulose isolation process in Kapok randu. Cellulose yield is the weight of cellulose produced from the cellulose extraction process from kapok randu. Cellulose yield affects the quality, durability, ability, and usefulness of the cel-

lulose produced. The yield analysis of kapok randu can be done by several processes. Starting from lignin fragmentation, acid hydrolysis, and cellulose characterization. Separation of lignin from kapok through an alkaline treatment process with NaOH can increase cellulose yield but can cause a decrease in cellulose crystallinity (Bhambure et al., 2022). In addition, research on range kapok cellulose yield is also essential to improve the quality and efficiency of the extraction process and to understand the influence variables such as NaOH concentration and extraction time on cellulose yield.

Based on the isolation process of kapok randu, in this study, the results of the cellulose yield of kapok randu after soaking are presented in Table 1.

Based on the Table 1, it can be explained that NDF (Natural Detergent Fiber) is an analytical method used to measure all-fiber components, including cellulose, hemicellulose, and lignin. NDF represents the cell wall content consisting of lignin, cellulose, hemicellulose and proteins associated with the cell wall. The highest value in the material indicates significant fiber content. In Table 3, it can be seen that the fibre material had the highest NDF content (96.33%), followed by the second highest NDF content of kapok fiber (91.25%) and cellulose M (90.03%) ranked third. These values indicate that all these materials are rich in fiber. High NDF content can affect several aspects. ADF (Acid Detergent Fiber) measures the fibre component consisting of cellulose and lignin. ADF is often used to measure the digestion of materials by microorganisms or animals.

The fiber material had the lowest ADF with a value of (78.88%) then the second was kapok fiber (84.21%), and the last was cellulose M (86.43%). Cellulose is the most abundant major fiber component, according to the data in Table 3. Cellulose has the highest cellulose content, with a value of (89.15%); next is kapok fiber, with a value of (79.45%) and the last is fiber material (66.22%). This showed that cellulose M has a high degree of purification. The high cellulose content in cellulose indicates that the material has excellent potential as a raw material for various applications, such as packaging, textiles, insulation, and so on. The high quality of fiber material can affect the digestibility of the material by micro-

Table 1 Cellulose yield of kapok randu after soaking

Extraction time (minute)	NaOH concentration		
	4%	6%	8%
40'	6,40 ± 0,63	5,87 ± 1,07	5,46 ± 0,64
50'	5,26 ± 1,13	5,77 ± 1,17	5,57 ± 1,01
60'	5,45 ± 1,54	5,65 ± 1,01	5,68 ± 0,41

organisms or animals, as well as the quality of the resulting feedstuff. Therefore, high cellulose content in cellulose indicates that the material has excellent potential as a raw material for various applications (Pause et al., 2019). Hemicellulose is a softer and more digestible fiber compared to cellulose. The fiber material has the highest hemicellulose content with a value of (17.45%); next is kapu fiber with a value of (7.04%) and the last is cellulose M with a value of (3.6%). Hemicellulose is a softer and more digestible fiber compared to cellulose. NDF was measured using the Van Soest method to determine the total fiber content. ADF (Acid Detergent Fiber) is composed of cellulose and lignin fiber. With the Van Soest method, lignin and hemicellulose will be broken down so that only cellulose remains. Hemicellulose is obtained from the calculation of NDF minus ADF. Hemicellulose is obtained from the calculation of NDF minus NDF, which means that hemicellulose is the part of NDF that is insoluble in acid detergent (ADF) (Christiyanto & Utama, 2021).

From the results of calculations using the ANOVA table, the yield resulting from the cellulose isolation process using NaOH with concentrations of 4%, 6%, and 8% and the length of extraction time, namely 40 minutes, 50 minutes, and 60 minutes, did not significantly affect the results of range kapok cellulose yield. Variations in NaOH concentration and variations in extraction time do not affect the cellulose yield of the kapok range because the cellulose isolation process in kapok only depends a little on NaOH concentration and extraction time variations. The concentration of NaOH used in the cellulose isolation process of kapok randu is only used as a solvent to facilitate the extraction process, not affecting the quality of the cellulose produced. The varying length of extraction time also does not significantly affect the yield because extracting kapok and cellulose only requires a relatively short time, so it does not matter if the extraction process is carried out at different times (Yuliatun & Santoso, 2022). Randu kapok cellulose extraction is a process of processing and kapok, which is carried out in three stages, the first of which is delignification, hydrolysis, and the last is the bleaching process. Delignification can be done by heating kapok fiber using NaOH solution. Hydrolysis can be done after the delignification process using Hydrogen peroxide (H_2O_2) solution with a ratio of kapok and H_2O_2 solution of 1:15 (100 gr: 1500 ml). In the following process is the kapok range that has been washed clean until the Ph is neutral; then kapok is bleached using NaOH and H_2O_2 dissolved in distilled water. The bleaching process is carried out to remove the remaining lignin color so that the kapok becomes pure white. After the cotton is bleached, the cotton is washed with clean water until the pH is neutral.

Chemical Tests of Fiber Raw Materials of Kapok Randu

Cellulose Chemical Tests of Kapok and Fiber Raw Materials to ensure the quality and characteristics of kapok and fiber, chemical tests can be conducted. The results of chemical tests of kapok and fiber raw materials are presented in Table 3.

Based on the results Table 2, the moisture content of kapok randu fiber with a value of 10.95% is a kapok randu fiber with reasonably low moisture content, indicating that kapok randu fiber has good stability and the risk of damage from fungi and microorganisms. Optimal moisture content can help prevent the growth of mold and other microorganisms. Conversely, if the moisture content in kapok and fiber is too high, it will affect the quality of the fiber's durability. High moisture can cause the fibers to become mushy and easily damaged and cause fungi and microorganisms to multiply, thus reducing the quality and durability of the fibers. Therefore, the low moisture content in kapok and fiber can be used in various applications without worrying about damage due to moisture (Soudagar et al., 2024).

The ash content of kapok randu fiber of 0.67% is a low ash content kapok randu fiber. There are indicated that the kapok and fiber are relatively free from chemical contamination and are considered exceptionally clean, making them suitable for products that require high cleanliness and purity. The low ash content in kapok randu fiber may contribute to the purity and cleanliness of the resulting product. Chemical contamination can compromise the product's quality and is hazardous if consumed. Therefore, the low ash content in kapok randu fiber indicates that kapok randu fiber is suitable for products that require high cleanliness and purity (Prayuda, 2020). The randu fiber content of 65.63% is a high fiber content of randu kapok fiber, indicating that randu kapok fiber has the potential as a good source of fiber for various applications, such as packaging, textiles, and so on. The high fiber content in kapok can contribute to good fiber quality. Kapok and fiber with high fiber content can be used as fillers for mattresses, pillows, and bolsters. High fiber content also has a more stable and more robust structure (Anggraeni, 2022). The chemical analysis of

Table 2 Chemical Tests of Fiber Raw Materials of Kapok Randu

Parameter	Percentage Content (%)
Water Content	10,95
Ash Conten	0,67
Fiber Content	65,63
Fat Content	0,25
Carbohydrate Content	36,62%

kapok randu fiber showed that kapok randu fiber has a low moisture, ash, and fiber content. The combination of these three parameters indicates that the kapok range fiber has good quality and the potential as a good raw material for various applications, such as packaging, textiles, insulation, and others. The excellent quality of kapok and fiber can be attributed to several factors. Firstly, kapok and fiber have a unique structure, allowing a more comprehensive range of raw material uses. Secondly, kapok randu fiber has properties that can increase the strength and durability of the resulting product. Furthermore, kapok and fiber have a relatively low production cost, making them a more economical choice for some applications (Anggraeni et al., 2024).

Comparative test of lignocellulose content

Lignocellulose is the main structural component of the plant cell wall, consisting of three main components: cellulose, hemicellulose, and lignin. Cellulose is the main component of lignocellulose, so lignin and other components must be reduced or removed because lignin can affect the final product produced. Analysis of lignocellulose in various materials can provide insight into the characteristics of these materials and can find applications in various industrial fields. Fig 1 showed that the comparative test results of lignocellulose content in three materials: Pure Kapok (KM), Delignified Kapok (KD), and Blaching Kapok (KB).

Based on Fig 1, it can be explained that NDF (Natural Detergent Fiber) is an analytical method used to measure all-fiber components, including cellulose, hemicellulose, and lignin. NDF represents the cell wall content consisting of lignin, cellulose, hemicellulose and proteins associated with the cell wall. The highest value in the material indicates significant

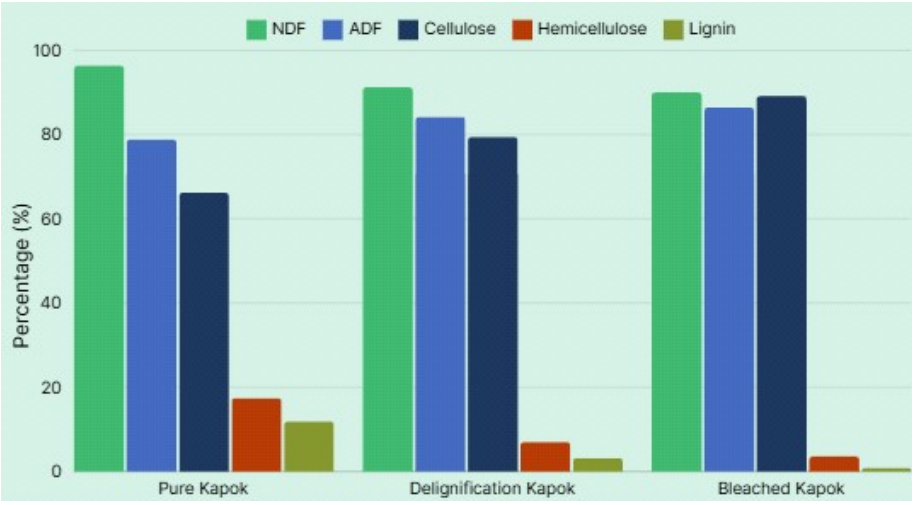


Fig 1. Comparative test results of lignocellulose content in three materials: Pure Kapok (KM), Delignified Kapok (KD), and Blaching Kapok (KB)

fiber content. In Table 3, it can be seen that the fibre material had the highest NDF content (96.33%), followed by the second highest NDF content of kapok fiber (91.25%) and cellulose M (90.03%) ranked third. These values indicate that all these materials are rich in fiber. High NDF content can affect several aspects. ADF (Acid Detergent Fiber) measures the fibre component consisting of cellulose and lignin. ADF is often used to measure the digestion of materials by microorganisms or animals.

The fiber material had the lowest ADF with a value of (78.88%) then the second was kapu fiber (84.21%), and the last was cellulose M (86.43%). Cellulose is the most abundant major fiber component, according to the data in Table 3. Cellulose M has the highest cellulose content with a value of (89.15%); next is kapu fiber with a value of (79.45%) and the last is fibre material (66.22%). This shows that cellulose M has a high degree of purification. The high cellulose content in cellulose indicates that the material has excellent potential as a raw material for various applications, such as packaging, textiles, insulation, and so on. The high quality of fiber material can affect the digestibility of the material by micro-organisms or animals, as well as the quality of the resulting feedstuff. Therefore, high cellulose content in cellulose indicates that the material has excellent potential as a raw material for various applications (Pause et al., 2019). Hemicellulose is a softer and more digestible fiber compared to cellulose. The fiber material has the highest hemicellulose content with a value of (17.45%); next is kapu fiber with a value of (7.04%) and the last is cellulose M with a value of (3.6%). Hemicellulose is a softer and more digestible fiber compared to cellulose. NDF was measured using the Van Soest method to determine the total fiber content. ADF (Acid Detergent Fiber) is composed of cellulose and lignin fiber. With the Van Soest method, lignin and hemicellulose will be broken down so that only cellulose remains. Hemicellulose is obtained from the calculation of NDF minus ADF. Hemicellulose is obtained from the calculation of NDF minus NDF, which means that hemicellulose is the part of NDF that is insoluble in acid detergent (ADF) (Christiyanto & Utama, 2021).

Lignin is the component that gives stiffness and structure to fibers. From Table 3, the fibre material has the highest lignin content with a value of (11.91%) indicating a higher level of stiffness. In comparison, kapu fiber and cellulose M have a much lower lignin content with (3.22% and 0.91%) values. High lignin content can affect the mechanical properties of fibers, such as tensile strength, elastic modulus, and total strain. High lignin content can increase fiber stiffness, so it can be used in applications that require high stiffness. Lignin is a “glue” that connects cellulose and hemicellulose, forming

structural parts and plant cells. Lignin is insoluble in air and stable in nature, so it functions as a "glue" that connects cellulose and hemicellulose (Nurjannah et al., 2020). The lignocellulose content comparison test results show that cellulose M has the highest cellulose content, making it suitable for applications requiring pure fiber. Kapok fiber has a reasonably high cellulose content with low hemicellulose and lignin content, making it a relatively light and flexible material. Fiber materials with higher lignin and hemicellulose content tend to be stiffer and can be used for applications that require higher structural stability. This analysis can help to understand the characteristics of such materials and how they can be optimally used in various industries, such as textiles, packaging, and other engineering applications.

Degree of whiteness

The next character is the degree of whiteness, which indicates the brightness of the kapok randu fiber. The test results of the degree of whiteness are shown in Table 3. Based on Table 4, the highest degree of whiteness is found in the treatment of 60 minutes extraction time and 8% NaOH concentration. This shows that the brightness or whiteness (Lightness) level in these treatment conditions is the highest. The bright color of the fiber will affect consumer acceptance as the fiber will look cleaner (whiter).

The Potential of Kapok Randu Cellulose as a Functional Composite Material Several factors support the potential use of the kapok range in functional composites, namely good mechanical properties, low density, biodegradability, diversity of applications, compatibility with the matrix, and the potential for sustainable product development. Kapok randu has good mechanical properties: high tensile strength, good flexural strength, and suitable elastic modulus. These mechanical properties make it suitable as a reinforcing material in composites to increase strength and resistance to mechanical loads. Kapok randu also has a low density that can reduce weight in composites. This is very advantageous in applications requiring lightweight materials, such as in the automotive and aviation industries. Kapok randu has biodegradability, sustainability, and environmentally friendly properties, which are essential in developing materials today (Zheng et al., 2015).

Kapok randu-based composites, these properties enable reduced environmental impact and better waste management as filtration. Kapok randu can be blended with various polymer matrices, such as natural and synthetic polymers, to form functional composites. The surface treatment process of kapok and fibers can improve the adhesion between the fibers and the matrix, thus improving the mechanical and thermal properties of the composite. Kapok can also

Table 3. Degree of whiteness from Concentration of NaOH and Time of Extraction Treatments

Time of Extractions	Concentration of NaOH		
	4%	6%	8%
40 minutes	19.57 ± 0.52a	22.66± 1.05a	25.40 ± 0.81a
50 minutes	21.58 ± 0.85a	24.45 ± 0.80a	26.02 ± 0.21a
60 minutes	22.80 ± 0.63a	26.70 ± 0.58a	31.16 ± 1.03a

be utilized in various types of functional composites. For example, it has been applied in the automotive industry to make light-weight and durable interior and exterior components. In addition, it has also been used in the construction industry to reinforce building materials and other sectors. Using kapok randu in functional composites can help reduce dependence on synthetic materials that are harmful to the environment. In addition, the development of kapok randu-based products can also provide added value and business opportunities for regions where kapok randu grows abundantly (Prachayawarakorn et.al. 2013).

Kapok randu fibre has several advantages that make it suitable to be used as an alternative textile material, because kapok randu fibre has the ability of materials that are not easily tangled, do not make fungi or microbes trapped in the fibre, and are lightweight. However, its use as a functional composite material still needs to be expanded to the use of stuffing for pillows, mattresses, shock material in helmets, raw material for paper, insulating material, and soundproofing material for soundproof rooms. The use of kapok fibre as a functional composite material is still limited due to several reasons, one of which is the lack of awareness in learning more about the use of kapok and in order to know more about the potential and worth of kapok randu fibre as a textile material that can be developed into a superior composite material (Sangalang, 2021). Furthermore, kapok randu leaves can also be used as organic fertiliser. Kapok randu leaves can be used to make organic fertilisers or natural pesticides. Certain compounds in kapok randu leaves play a role in repelling pests or can fertilise the soil as a planting medium (Fauziah & Sari, 2020). The kapok randu tree (Ceiba et al.) also has the potential to be used as an economically valuable product. The randu tree can be used as raw material for making plywood and pulp.

On the other hand, because randu wood is classified as soft wood, it is not recommended for heavy building construction. However, it can still be used as a raw material for making paper pulp and plywood. In addition, randu trees can also improve the environment, such as in reforesting critical land or areas affected by deforestation. Its strong roots can serve as a soil barrier that can prevent erosion and flood disasters and become a buffer for other plants (Gea et al., 2023).

Another part of the kapok is the kapok and flower. Kapok and flowers also have pretty interesting potential, such as being a source of honey, where honey from orange tree flowers is produced by specific bees that only want to take honey from orange tree flowers. This honey effectively treats many diseases, such as fever, mouth ulcers, and burns, and can improve brain intelligence. In addition, honey can also be used as an external medicine and internal medicine to treat various diseases such as diarrhea, diabetes, hypertension, headaches, wound medicines, and so on (Pradani et al., 2023). Kapok and seeds can be utilized as a source of calories and carbohydrates, while protein is relatively high. This causes kapok and seeds to be used as an alternative food. Kapok and seeds contain edible oil that can be extracted as a flavoring, cosmetic ingredient, or biofuel. The residue from the excretion of kapok randu seeds can also be used as a medicine for influenza and bronchitis in traditional medicine (Hidayati, 2020).

CONCLUSIONS

Kapok range is a natural fiber that has considerable potential in the form of cellulose and can be enhanced by physical or other mechanical values to cellulose. Kapok randu is also a significant natural source of cellulose fiber. The cellulose in the kapok range varies depending on certain factors, such as the tree's age, growing conditions, and the part of the plant used. This research focuses on the method of cellulose isolation from kapok randu with variations in NaOH concentration (4%, 6%, and 8%) and extraction time (40, 50, and 60 minutes). The cellulose isolation process showed that the method did not significantly affect the cellulose yield of kapok randu. The variation of NaOH concentration and extraction time did not affect the cellulose yield of kapok randu because the cellulose isolation process in kapok randu was independent of the variation of NaOH concentration and extraction time. Kapuk randu fiber has a relatively low moisture content, low ash content, and fairly high fiber content.

This study showed that the cellulose isolation method with variations in NaOH concentration (4%, 6%, and 8%) and extraction time (40, 50, and 60 minutes) did not significantly affect the yield of kapok randu cellulose. Therefore, it is recommended to conduct further research that is more specific and focused on variables that are more important to improve cellulose quality. In addition, it is recommended to conduct further analysis of the data that has been collected to understand more about the factors that affect cellulose yield and consider factors such as temperature, time, and chemicals used to improve cellulose quality. Thus, this research can contribute to developing more effective and efficient cellulose isolation technology.

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