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Effect of Decortication Process and 5% NaOH Treatment Industrial Ramie Fiber (*Boehmeria Nivea Linn*) on the Tensile Strength

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Ramie fiber has the potential to be developed into bio composites. Many factors affect the character of ramie fiber such as climate, age, harvesting, and decortication. In addition, some chemical treatments such as Alkali treatment, silane treatment, Acetylitation, and Peroxide treatment also affect the physical and mechanical characteristics of ramie fiber. This paper studied the effect of decortication process and 5% wt NaOH treatment for 2 hours on fiber tensile strength. The result showed that fiber decortication process, and 5% wt NaOH treatment for 2 hours has effect on the tensile strength of single fiber.

Keywords: Ramie Fiber, Decortication, NaOH Treatment.

1. INTRODUCTION

The over expanding consumption of nonrenewable resources, such as petroleum, has intrigued to study the practical application of green materials in attempt to reduce it. Natural fibers are one of the potential green material, which are light, strong, inexpensive, renewable and ecofriendly. On the other hand, "green" composites biodegradable materials resin matrix composite reinforced by natural fibers were expected to be an important material for realizing and maintaining a sustainability productive society.[1] The success of natural fiber composites (NFCs) depends on their ability to overcome their main disadvantages, such as low fiber/matrix adhesion, fluctuations in fiber properties, low thermal and fire resistance; and the possibility of using well-studied glass fiber reinforced plastics (GFRP) processing techniques.[2] Mercerization, a relatively simple alkali treatment, has been successfully used in fibers to increase the fiber-matrix adhesion. Ramie fiber, as a potential material for reinforcement in polymer composite, has mechanical properties in average higher than the other natural fibers. Ramie fiber is an abundant natural resource that is available in continuous form with the length between 60 and 250 mm and its physical characteristic is one of the benefits for reinforcement fiber polymer composite in continuous form applied for panel.[3]

Reinforcing efficiency of natural fiber depends on the nature of cellulose and its crystallinity.[4] Components that are present in natural fibers are cellulose (α-cellulose), hemicelluloses, lignin, pectin and waxes.[4]

Table I. Chemical composition of ramie fiber.

Fiber	Cellulose (wt%)	Hemicellulose (wt%)	Lignin (wt%)	Waxes (wt%)
Ramie	68,6–76,2	13–16	0,6–0,7	0,3

Many factors affect the character of ramie fiber such as climate, age, harvesting, and decortication. The decortication process affected texture, color, and tensile strength of ramie fiber. Field study in PT Rabersa in Wonosobo, Central Java, Indonesia showed decortication process is possible to conduct with water and without water.

Furthermore, other chemical treatments such as alkali treatment, silane treatment, acetylation, and peroxide treatment also affect the physical and mechanical characteristics of ramie fiber. Mercerization is one of the best-used chemical treatments for natural fibers. Alkali treatment yields an increase in the amount of amorphous cellulose at the expense of crystalline cellulose occur in alkali treatment 1. The impact of this treatment is a removal of hydrogen bonding in the network structure. NaOH treatment affected fiber surface in chemical and physical modification.[5] The reaction that takes place during this treatment is shown below.

$$\text{Fiber-OH} + \text{NaOH} \rightarrow \text{Fiber-O-Na}^{+} + H_2O$$

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(a) (b) (c)

Fig. 1. Ramie fiber processing (a) ramie harvesting (b) ramie fiber decortication (c) ramie fiber naturally drying.

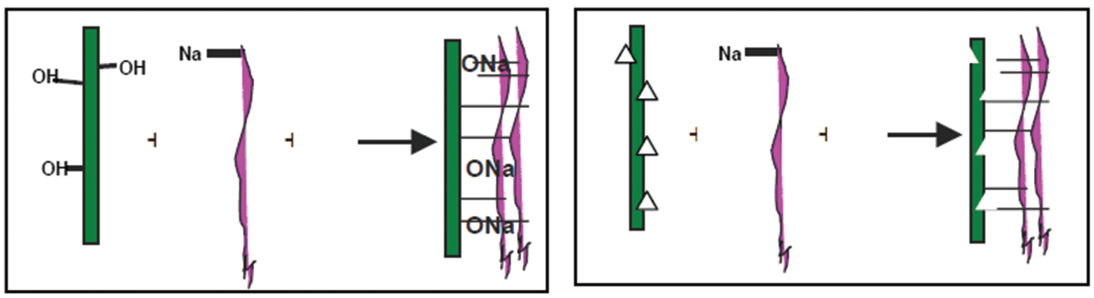

Fig. 2. Effect NaOH treatment on ramie fiber surface (a) chemical modification (b) physical modification.

The aim of this research is to evaluate the effect of decortication process and the alkali treatment on the tensile strength single ramie fiber.

2. EXPERIMENTAL DETAILS

Industrial ramie fibers were supplied by PT Rabersa Wonosobo region, Central Java, Indonesia. NaOH flake were purchased from local commercial sources.

Ramie decortication process was conducted with machine and it can be done with and without water, while the decortication process with water used stream water. Next, Ramie fibers were soaked in 5% sodium hydroxide solution at ambient temperature. The fibers were immersed in the solution for 2 hours. After treatment, the fibers were washed thoroughly with water to remove the excess of NaOH and dried at the ambient temperature for 7 days.

Tensile strength of single ramie fibers was measured according to the ASTM D3379-7. Single fiber ramie was separated from fiber bundles by hand, and then attached to a sheet of paper. The diameter was measured at four points along each fiber using an optical microscope, and the smallest diameter was used to calculate the tensile properties of fibers. The fibers were assumed to have a cylindrical shape. Then 15 single fiber specimens in every condition (decortication with water untreated, decortication with water 5% wt NaOH treatment, decortications without water untreated, decortication without water 5% wt NaOH treatment) were placed in the mounting as seen on Figure 3.

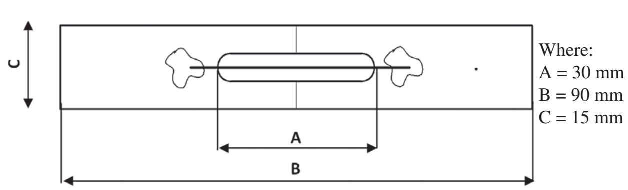

Fig. 3. Single fiber tensile strength specimen.

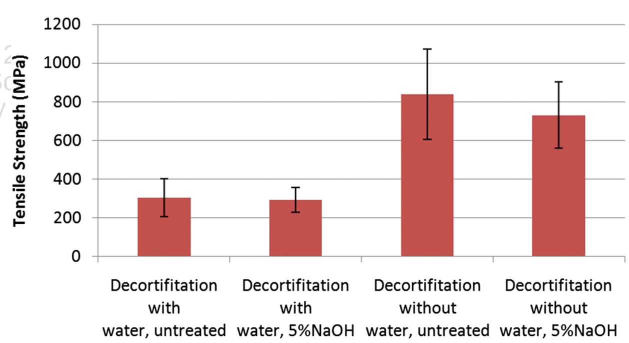

Fig. 4. The results of tensile strength test on the fiber treatment.

The mounted fibers were then placed in the grips of an MESDAN LAB, S.p.a Model Tenso 300. Tensile testing of the fibers was carried out at a crosshead speed of 250 mm/min using a 300 g-load cell.

Table II. Types of fiber treatment used and diameter measurements.

Fiber treatment	Diameter (μm)
Decortication with water, untreated	44,85 ± 13,22
Decortication with water, 5% NaOH	42,02 ± 9,40
Decortication without water, untreated	32,26 ± 7,36
Decortication without water, 5% NaOH	30,85 ± 8,49

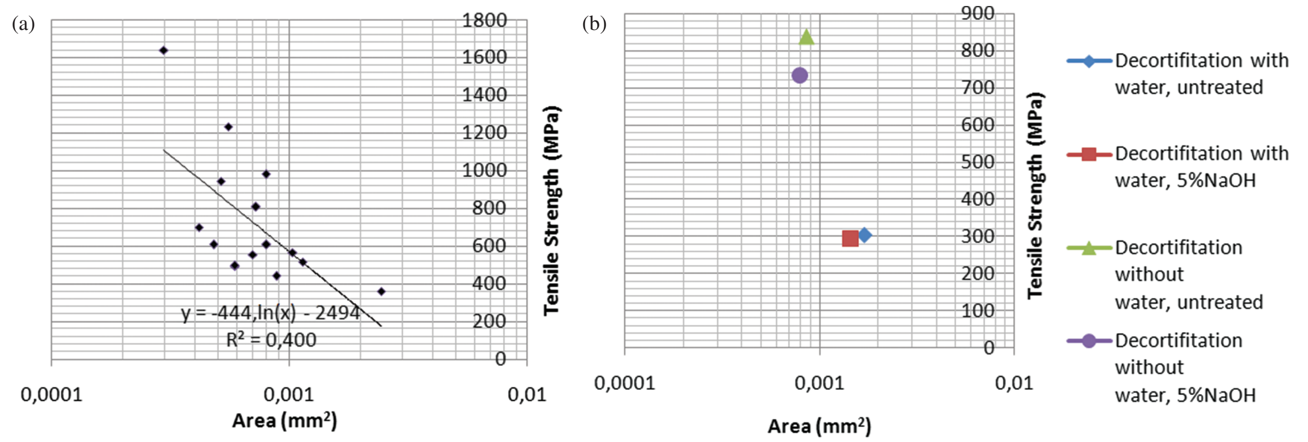

Fig. 5. (a) Correlation area and tensile strength (b) average tensile strength with many types of fiber treatment.

3. RESULTS AND DISCUSSION

The Decortication without water 5% wt NaOH had a smallest fiber diameter, and the biggest diameter found from Decortication with water untreated. Treatment 5% wt NaOH for 2 hours process leads to a decrease in fiber diameter, as a consequence of the collapse of its cellular structure.[2] Table II showed single fiber diameter measurements.

The tensile strength test results of the single fiber suggested that the decortication of fiber without water had higher results than the group of decortication with water. While the treatment of 5% NaOH in the single fiber decortication led to the tensile strength decrease compared to without NaOH treatment.

The single ramie fiber tensile strength properties thus evaluated are presented as a function of total area. It can be seen that tensile strength of fibers decrease with increasing area within the range studied (0.00030–0.0024 mm^2) (see Fig. 5(a)), as observed in the case of pineapple fibers[6] and coconut fiber.[7] Furthermore, the same comparison has been done for the four studied fibers with their total areas (Fig. 5(b)) and its clear that tensile strength of fibers decrease with increasing area.

4. CONCLUSION

In conclusion, this study suggested that the decortication process of single fiber influenced the tensile strength in which higher results occurred on group of decortication process without water. On the other hand, the treatment of 5% NaOH to the decortication caused the decrease of the singe fiber tensile strength.

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References and Notes

1. A. Gomes, K. Goda, and J. Ohgi, *JSME Int. J., Ser. A* 47, 4 **(2004)**.
2. E. S. Rodríguez and A. Vázquez, *Proceedings of the 8th International Conference on Flow Processes in Composite Materials*, Douai, France, July **(2006)**.
3. E. Marsyahyo, Jamasri, H. S. B. Rochardjo, and Soekrisno, *Journal of Industrial Textiles* 39, 1 **(2009)**.
4. R. Kumar, S. Obrai, and A. Sharma, *Der. Chemica Sinica* 2, 4 **(2011)**.
5. E. Marsyahyo, R. Soekrisno, H. S. B. Rochardjo, and Jamasri, *Proceedings of SNTTM V-BKSTM* **(2006)**.
6. P. S. Mukherjee and K. G. Satyanarayana, *J. Mater. Sci.* 21 **(1986)**.
7. F. Tomczak, T. H. D. Sydenstricker, and K. G. Satyanarayana, *Composites Part A* 38 **(2007)**.

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