TECHNIUM
Romanian Journal of Applied Sciences and Technology
ISSN: 2668-778X

vol. 17 / 2023

The 7th International Conference on Science Technology

organized by
Faculty of Social Science and
Law Universitas Negeri Manado and
Consortium of International Conference
on Science and Technology

The Innovation Breakthrough in Digital and Disruptive Era

PLUS COMMUNICATION

International Communication & PR

Technium: Romanian Journal of
Applied Sciences and Technology
Vol. 17, 186-189, November, 2023
ISSN: 2668-778X
www.techniumscience.com

Effect of Processing Treatment of Pineapple Leaf Fiber (PLF) with Liquid Smoke on Tensile Properties and Impact of Pineapple Fiber Reinforced Composites

Mukhlis Muslimin[1*], *Kifli Umar*[1], *Sandi Rais*[1], and *Raulia Taib*[2]

[1]Mechanical Engineering Departement, Khairun University, 97719 Ternate, Indonesia
[2]Student of Mechanical Engineering Departement, Khairun University, 97719 Ternate, Indonesia

Abstract. Research objectives to determine the effect of treating pineapple leaf fiber (PLF) with liquid smoke on the tensile toughness of composites and the impact strength of pineapple leaf fiber (PLF) reinforcement. The Method of immersing the fiber with liquid smoke was done in 1, 2, and 3 hours, then heating it in the oven at 40ºc for 30 minutes. A tensile and impact test specimen following the ASTM D638 – Type IV standard and ASTM D5942 standard. The tensile strength of the composite at 1 hour of treatment was 64.42 MPa; at 2 hours, it increased by 72.53 MPa, and at 3 hours, it increased again by 74.65 MPa. In the composite impact test with fiber reinforcement, the 1-hour treatment was 9.32 J/m², the 2-hour treatment increased by 13.44 J/m², and the 3-hour immersion decreased by 10.21 J/m². The effect of liquid smoke treatment processing on PLF on the tensile strength and impact toughness of the composites shows that the PLF reinforcing composite experienced the most significant change in tensile strength at 3 hours of treatment, and impact toughness occurred at 2 hours of treatment; this shows that liquid smoke can change the strength of PLF to be stronger and tougher.

Keywords. Pineapple Leaf FIber, Liquid Smoke, Pineapple Fiber Composite

* Corresponding author: mukhlis@unkhair.ac.id

TECHNIUM

Technium: Romanian Journal of
Applied Sciences and Technology
Vol. 17, 186-189, November, 2023
ISSN: 2668-778X
www.techniumscience.com

1 Introduction

It is believed that the use of natural composites will experience a lot of improvement due to the increasing demands for environmental preservation. This is supported by government policies towards the use of goods derived from renewable and biodegradable resources. To avoid the further deterioration of environmental quality due to the use of petroleum-based materials, many natural composites are currently being developed which include several types of natural fibers such as hemp, bamboo[1], banana[2], palm oil, and others. These materials function as composite reinforcing fibers to replace glass fibers.

A Composite is a material formed from a combination of two or more materials to become a composite that has different properties and mechanical characteristics of the constituent materials. Composites have better mechanical properties than metals, stiffness (Young's modulus), and higher specific strength than metals. Several composite laminae can be stacked with fibers oriented in different directions, the combined laminae are referred to as laminates. Natural fiber-reinforced composites as two or more types of materials combined on a macroscopic scale that can be used as new materials that are environmentally friendly. Composites consist of 2 main parts/structures, namely the matrix (binder) and filler (reinforcement).[3]

North Maluku has abundant biodiversity and opportunities to process natural fiber materials as composite reinforcement. Pineapple plants grow a lot in the West Halmahera area of Boso Village, and the custom of the people there is only to take the fruit to eat and sell and waste the leaves. The pineapple leaves have fiber that can be used as a composite reinforcement material but need research to determine the characteristics of pineapple fiber.

Pineapple leaf fiber is another source of natural fiber promising to be developed long-term as a reinforcement for composite materials. Pineapple leaf fiber is relatively cheap because this source is widely available in various regions in Indonesia. In addition, pineapple leaf fiber has good specific mechanical properties and is environmentally friendly. Pineapple leaf fiber has the potential to be used as a composite reinforcement. However, it needs treatment so that the mechanical properties and resistance to the outside environment can be maintained from bacterial contamination, directions, and voids in the printing process.

Several researchers have previously treated the fiber so that it has good mechanical properties; treating fiber with NaOH can improve mechanical properties[4], treating fiber with seawater can improve mechanical properties[5], treatment fiber with turmeric can improve mechanical properties[6], treatment of fibers with silane can improve the mechanical properties [7][8], improvement of the mechanical properties of the fiber can be done by liquid smoke treatment [9][10][3].

From the many treatment methods, there is an interesting liquid smoke treatment to consider as a treatment method because liquid smoke not only has the mechanical properties of fibers but can also protect fibers from bacterial attack because liquid smoke has antibacterial properties [11]. So that in recent years fiber research has developed by treating fiber with liquid smoke [12][10][13][14][9][15][16].

The pineapple leaf fiber reinforced composite used a reinforcing material for the yukalac 157 resin matrix composite. Adding a reinforcing agent at a specific concentration can produce its constituent materials' mechanical, thermal, and structural properties. Polyester resin is also perfect and widely used in the maritime transportation industry. Based on the description above, research has revealed the effect of liquid smoke treatment on pineapple leaf fibers on the tensile and impact strength of composites.

2 Materials and Method

The material used is pineapple leaf fiber (PLF); the method in this study is experimental. The material for this research is PLF from North Maluku Province. The picture is as follows:

Fig.1. Pineapple leaf fiber

Fiber collection is done by taking cleaned pineapple leaves with clean water and then soaked in water for seven days. Fiber is taken by combing pineapple leaves until fine fibers appear; before making the composite, a treatment consisting of two methods: fiber immersion treatment with liquid smoke with a variation of soaking time, namely 1, 2, and 3 hours. The fiber was dried in a UN 55 Cap 53L memmert oven at 40°C for 30 minutes.

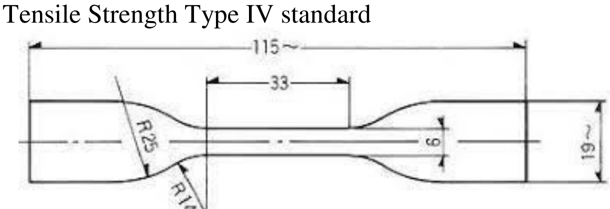
Tabel.1 Treatment notation on CFF

No	Notation	Code	Treatment
1	1-hour treatment	P1J	Liquid smoke *grade (III)*
2	2 hours treatment	P2J	Liquid smoke *grade (III)*
3	3 hours treatment	P3J	Liquid smoke *grade (III)*

After immersion, the test specimens were then made by cutting 10mm, then printed into a composite with 30% fiber and 70% resin. The treatment of composites were carried out by tensile and impact testing with ASTM D638 – Type IV and ASTM D5942 standards.

Tensile Strength Testing

Specimen testing according to ASTM D638 – Tensile Strength Type IV standard



Technium: Romanian Journal of Applied Sciences and Technology
Vol. 17, 186-189, November, 2023
ISSN: 2668-778X
www.techniumscience.com

Fig. 2. Standard ASTM D638-Type IV

Impact Toughness Testing

Specimen testing according to ASTM D5942-96 Standard Impact Toughness of Composites

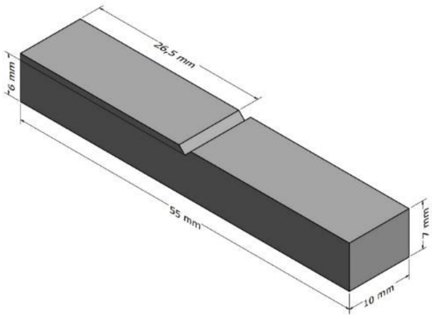


Fig. 3. Standard ASTM D5942-96

3 Result and Discussion

3.1 Effect of Liquid Smoke Treatment Processing on Composite Tensile Strength

The result from the composite tensile test shown an increasing of tensile strenght in 1,2 and 3 hours treatment by 64.42 MPa, 72.53 MPa, and 74.65 MPa for 2 and 3 hours treatment. The following graph shows the result of the composite tensile test.

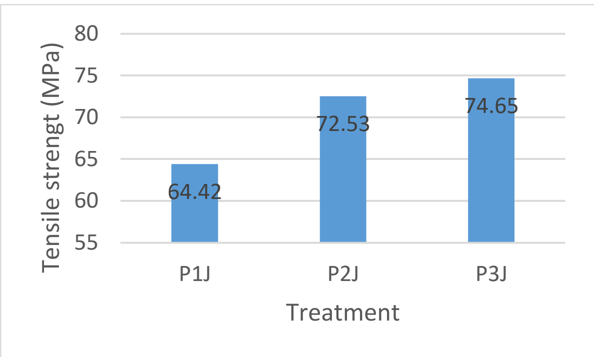


Fig.4. Effect of liquid smoke treatment on composite tensile strength

Changes in the tensile strength of composites reinforced with PLF greatly determine the mechanical properties of the composite, based on the results of research on the graph above shows that liquid smoke can change the mechanical properties of PLF-reinforced composites ; the longer the treatment time, the better the tensile properties of the composite because liquid smoke affects the formation of rough and porous fiber surfaces [11], so in the process of forming resin composites as an input matrix into the pores of the fiber to form a bond between the fiber and the matrix the better.

3.2 The Effect of Liquid Smoke Processing on Composite Impact Toughness

The highest effect of liquid smoke treatment on composite impact toughness was on treatment in 2 hours by 13.44 Mpa. The treatment on 1 and 3 hours results in 9.32 MPa, and 10.21 MPa. The effect of liquid smoke treatment on composite impact toughness show on figure 2.

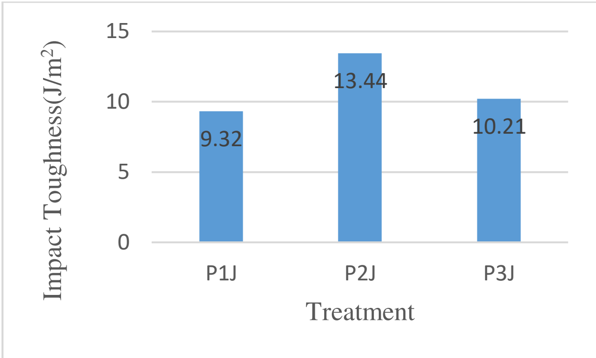


Fig.4 Effect of Liquid Smoke Treatment on Impact Toughness

The results show that the impact toughness of PLF-reinforced composites with 2 hours of treatment has the highest mechanical properties. The effect of liquid smoke on the PLF surface increases the interfacial bond between the fibers. PLF treated with liquid smoke acts as a filler, forming a better fiber surface, thereby promoting increased adhesion between the fiber and the epoxy matrix. This enhanced interfacial bond leads to improved load transfer and overall structural integrity, ultimately contributing to increased composite tensile and impact strength.

The increase in mechanical properties provides an opportunity for the use of PLF to be a very potential composite, because this can support the needs of non-metallic materials in the future.

Conclusion

The effect of liquid smoke treatment on PLF on the tensile strength of the composite occurred in the 3-hour treatment of 74.65 MPa, and the impact toughness of the composite occurred in the 2-hour treatment of 13.44 J/m2. Hence, liquid smoke can improve the mechanical properties of the fiber as a composite reinforcement.

References

[1] S. S. Chee, M. Jawaid, M. T. H. Sultan, O. Y. Alothman, and L. C. Abdullah, "Thermomechanical and dynamic mechanical properties of bamboo/woven kenaf mat

Technium: Romanian Journal of
Applied Sciences and Technology
Vol. 17, 186-189, November, 2023
ISSN: 2668-778X
www.techniumscience.com

reinforced epoxy hybrid composites," *Compos. Part B Eng.*, vol. **163**, no. 1, pp. 165–174, 2019.

[2] T. A. Nguyen and T. H. Nguyen, "Study on Mechanical Properties of Banana Fiber-Reinforced Materials Poly (Lactic Acid) Composites," *Int. J. Chem. Eng.*, vol. **2022**, 2022.

[3] W. A. Wirawan, A. Sabitah, M. A. Choiron, M. Muslimin, A. Zulkarnain, and B. W. Budiarto, "Effect of chemical treatment on the physical and thermal stabillity of Hibiscus Tiliaceus Bark Fiber (HBF) as reinforcement in composite," *Results Eng.*, vol. **18**, no. April, p. 101101, 2023.

[4] M. Arsyad, "Effect of alkali treatment on the coconut fiber surface," *ARPN J. Eng. Appl. Sci.*, vol. 12, no. 6, pp. 1870–1875, 2017.

[5] Mardin, I. N. G. Wardana, K. Kusno, and S. Wahyono, "Sea Water Effects on Surface Morphology and Interfacial Bonding of Sugar Palm Fiber to Sago Matrix," vol. **724**, pp. 39–42, 2016.

[6] I. Renreng, R. Soenoko, pratikto, and Y. Surya Irawan, "Effect Of Turmeric (Curcuma) Solution Treatment Toward The Interfacial Shear Stress And Wettabilty Of A Single Fiber Akaa (Corypha) On Epoxy Matrix," *Int. J. Appl. Eng. Res. ISSN*, vol. **10**, no. 10, pp. 973–4562, 2015.

[7] W. A. Wirawan, M. A. Choiron, E. Siswanto, and T. D. Widodo, "Analysis of the fracture area of tensile test for natural woven fiber composites (hibiscus tiliaceus-polyester)," *J. Phys. Conf. Ser.*, vol. **1700**, no. 1, 2020.

[8] M. Asim, M. Jawaid, K. Abdan, and M. R. Ishak, "Effect of Alkali and Silane Treatments on Mechanical and Fibre-matrix Bond Strength of Kenaf and Pineapple Leaf Fibres," *J. Bionic Eng.*, vol. **13**, no. 3, pp. 426–435, 2016.

[9] M. Muslimin, kusno Kamil, S. A. S. Budi, and I. Wardana, "Effect of liquid smoke on surface morphology and tensile strength of Sago Fiber," *J. Mech. Eng. Sci.*, vol. **13**, no. 4, pp. 6165–6177, 2019.

[10] M. Mukhlis, W. Hardi, and R. Mustafa, "The Effect of Treatment of Coconut Fiber with Liquid Smoke on Mechanical Properties of Composite," *E3S Web Conf.*, vol. **328**, p. 07010, 2021.

[11] F. Swastawati, E. Susanto, B. Cahyono, and W. Aji, "Quality Characteristic and Lysine Available of Smoked Fish," vol. **2**, no. 2007, pp. 1–6, 2012.

[12] M. Muslimin, K. Kamil, and I. N. G. Wardana, "Cross-sectional texture of sago fiber due to liquid smoke treatment," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. **1125**, no. 1, p. 012114, 2021.

[13] M. Muslimin, "Effect Of Liquid Smoke on The Morphology and Compatibility of Sago Fiber-Matrix," in *Seminar Nasional Inovasi Teknologi*, **2022**, pp. 47–51.

[14] M. Muslimin, M. Rahim, A. Seng, and S. Rais, "Liquid Smoke Treatment for Natural Fibers : The Effect on Tensile Properties , Surface Morphology , Crystalline Properties , and Functional Groups of Banana Stem Fibers," *Appl. Syst. Innov.*, vol. **5**, no. 94, pp. 1–12, 2022.

[15] M. Muslimin, S. A. S, W. I. N. G, and K. Kamil, "Liquid Smoke Potential Solution on Texture and Bonding Sago Fiber- Matrix," vol. **494**, 2019.

[16] M. Muslimin, K. Kamil, S. A. S, and W. I. N. G., "Effects of Liquid Smoke on the Chemical Composition and Thermal Properties of Sago Fiber," *J. SOUTHWEST JIAOTONG Univ.*, vol. **54**, no. 1, pp. 1–11, 2019.