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Effect of Fiber Length and Alkalization Treatment on the Tensile Properties of Musa Paradisia Banan Stick Fiber Composite

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ABSTRACT

Composite materials are widely used and in demand in various applications, because they have advantages such as being light and relatively strong. The basic material used in this composite uses natural fiber because the fiber is environmentally friendly and is available in abundance in nature, making it more economical. The matrix as a binder uses epoxy. This research was conducted to determine the comparison of tensile strength of composites due to the influence of alkalisation and non-alkalization with a concentration of 5% NaOH for 2 hours with fiber lengths of 5 cm and 7 cm. The composite specimens made refer to the ASTM-D638 standard. The research method used four stages, namely taking kepok banana tree frond fibers, making composites, tensile testing and SEM testing. The highest tensile test results occurred in composites with alkalization treatment with a fiber length variation of 5 cm, namely 39.54 MPa. Meanwhile, the highest value for the composite without alkalization treatment occurred at a fiber length of 5 cm, namely 39.19 MPa. The highest elastic modulus value occurred in the composite with a 7 cm fiber variation of 4.76 GPa with alkalization treatment

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INTRODUCTION

The current development of the industrial world causes the need for materials to increase, especially for products. The use of metal materials in various product components is decreasing. This is due to the weight of components made of metal, the formation process is relatively difficult, they can experience corrosion and the production costs are expensive, therefore many other materials have been developed that have properties that match the desired characteristics of metal materials. Because of this, the manufacturing industry has now innovated to use natural fibers such as banana stem waste as a material that is safe to use and reduces the use of metal, thus also having benefits for the environment so that waste in the environment can be reduced. Another factor that contributes to innovation is that Indonesia is an agricultural country that has various natural resources which should be utilized optimally for the benefit of society. In Indonesia itself, banana trees are the most common plant and grow abundantly in Indonesia. [1]

One of the materials that is currently being developed is composite. The materials that make up the composite must have clear proportions, namely the fibers as reinforcement are usually called fibers and the binder is called matrix. let's say greater than 5%. Second, the composition material has different properties and also the properties of the composite formed are different from the properties of the composition material. Several types of natural fibers that have been used as composite reinforcement include pineapple fiber, water hyacinth fiber, sisal, hemp, flax, e-glas, abaca, coconut fiber and bamboo fiber (Bakri 2011) [2]. According to Maulida, 2006 banana stem fiber and pandan fiber were used to replace synthetic fibers and polypropylene was used as a matrix, the strength of pandan stem fiber with a thickness of 1 mm was better than the tensile strength of banana stem fiber with the same thickness, the thicker the composite produced, the lower it was. tensile strength on the same number of fibers [3]. The concept of green composites emerged as a solution to the problem of synthetic composites which have several weaknesses such as being difficult to decompose in nature [4]. The following natural fibers have been widely studied as composite materials such as cotton, wool, silk, banana fronds, palm fiber, pineapple, coconut fiber, bamboo and kenaf [5]. The advantages of natural fibers are that they are environmentally friendly, have a low density and have a relatively light weight. There are four main groups of materials for the automotive field: metals, plastics, composites and ceramics. Thoitullah [6] studied the effect of fiber soaking time (1-4 hours) on tensile strength values. Irwan [7] Mechanical properties of polymer composite material reinforced with kapok banana stem fibers due to tensile loads with a fiber length of 15 cm, width of 1 cm and thickness of 0.5 cm has a maximum tensile stress value of 38.7218 MPa and an average stress of 19.361N. Pramono [8] Tensile strength figures for kapok banana stem fibers show an average tensile strength figure without treatment of 1766.156 MPa. Pisan midrib fiber with 5% NaOH alkalization for 2, 4 and 6 hours had an average tensile strength value of 1801.756 MPa, 782.908 MPa and 799.497 MPa. Based on the description above, this research focuses on the effect of alkalization treatment and variations in fiber length on the mechanical properties of composites with epoxy matrices and banana tree stem fibers. By comparing the soaking times, it is hoped that the soaking time will be effective in removing lignin, hemicellulose and dirt from the fiber.

METHODOLOGY

Research Stages:

A. Extraction of fiber from banana stems

1) Banana stems from banana plantation waste are cut to a size of 50 cm so that the process of extracting fiber is easier
2) Banana stems are dried in the sun until dry before the fiber is taken, this is done so that the water content in the banana stems is removed easily. when taking the fiber
3) The banana stem is combed using a wire brush to separate the fiber from the particles in the banana stem
4) The separated fiber is then dried in the sun for 2-3 days, but the drying is done without direct contact with sunlight.

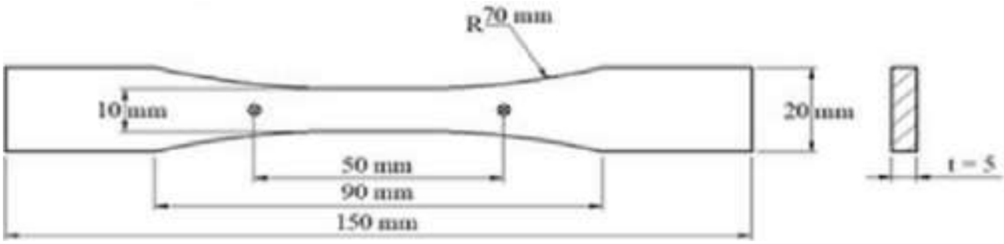
B. Making Specimen Molds

The material used for this mold is acrylic. By using this material, it is hoped that the specimen will be easier to remove. 24 test specimens were made one by one, with details of 20 for the tensile test and 4 for the SEM test. The test carried out is a tensile test referring to the ASTM-D638 standard.

C. Composite Manufacturing Process

The process for making fiber composites from banana stem midribs with a polyester matrix is as follows:

1. The fiber has been extracted, then soaked and washed from dirt with water. The fiber is aired until dry in a shady place. The fibers that have been cleaned of dirt are then soaked in NaOH alkaline solution for 2 hours. The fiber is then rinsed with clean water, then the fiber is dried in a place that is not exposed to direct sunlight.
2. Clean the mold, then apply water or oil evenly so that the composite does not stick to the mold.
3. Make a mixture of resin and catalyst in a ratio of 99:1, then stir until evenly distributed for 4 minutes.
4. Insert the banana tree stem fiber into the mold that has been cut to a length of 5 cm and 7 cm, then pour the resin until it is full while pressing to avoid air bubbles.
5. Install the mold lid so that the composite surface is flat, then put a load on top.
6. Allow to dry for 2 hours, then remove the composite from the mold.
7. The composite test object is ready to be cut into test object specimens.
8. Perform the steps above for each banana tree stem fiber that will be used for testing.



Gambar 1. Spesimen Uji Tarik ASTM D 638

RESULTS AND DISCUSSION

This research uses a composite made from natural fibers, namely banana stem fiber. Four test specimens were prepared. The tests carried out were Tensile tests and SEM (Scanning Electron Microscope) tests, for each specimen having a fiber volume fraction of 30%.

Table 1. Average Tensile Test Results for Kepok Banana Leaf Fiber Composite with Alkalization treatment 5% NaOH

No	Panjang serat (cm)	Fraksi Volume serat (%)	Kekuatan Tarik (MPa)	Regangan	Modulus Elastisitas (GPa)
Alkalisasi					
1	5	30	39,54	9,01	4,36
2	7	30	36,68	8,81	4,76
Non Alkalisasi					
3	5	30	39,19	10,26	4,23
4	7	30	37,67	8,16	4,62

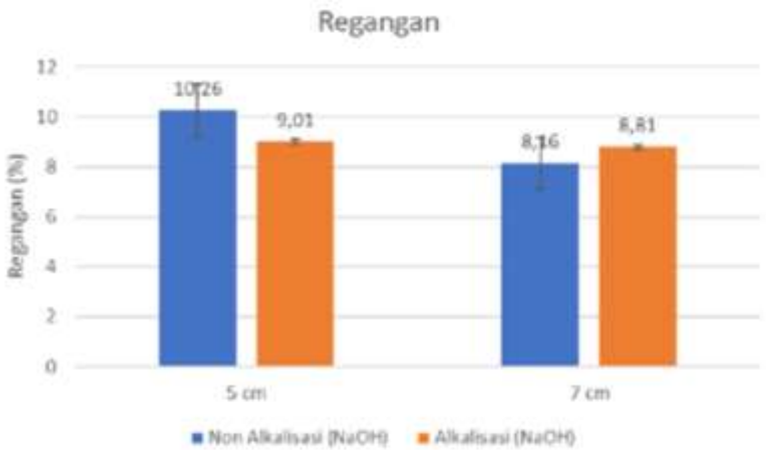


Figure 2. Tensile Strenght Geaph of 5 cm and 7 cm Composites Treated with Alkalization and non-Alkalization

The results of tensile test research on banana tree frond fiber composites which were carried out with 5% NaOH alkalisation treatment had a tensile strength of 39.54 MPa, while without alkalization treatment it had a tensile strength of 39.19 MPa. This is because the frond fiber of the Kepok banana tree still has a layer that resembles wax on the surface of the fiber, such as lignin, hemicellulose and other impurities. By removing this wax layer, the bond between the fibers and the matrix will become stronger, resulting in a higher tensile strength of the composite.

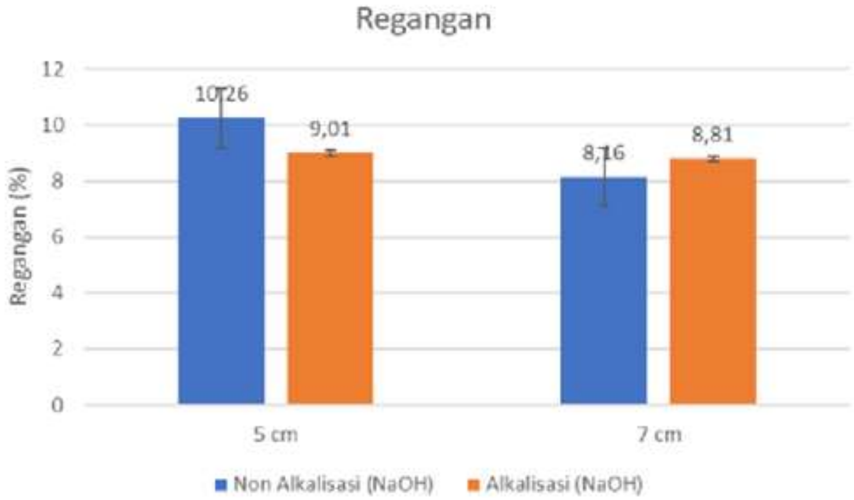


Figure 3. Graph of the Relationship Between Composite Strain and Alkalinization and non-Alkalization Treatment

The length of the frond fibers of the Kepok banana tree has an influence on the amount of strain in the composite. This is because the fiber itself has tensile strength, so that the pisan kepok tree frond fiber is able to support the composite material. The longer the fiber, the smaller the tensile strain value of the composite. Meanwhile, short fibers tend to have structural weaknesses in the composite, causing greater strains. Judging from Figure 3, the results of the alkalinization strain are greater, namely 9.01%, whereas with non-alkalization treatment, the banana tree frond fiber has a value of 10.26%. This is because in the non-alkalization treatment, the composite has voids and fractures in the fibers so the strain value is greater.

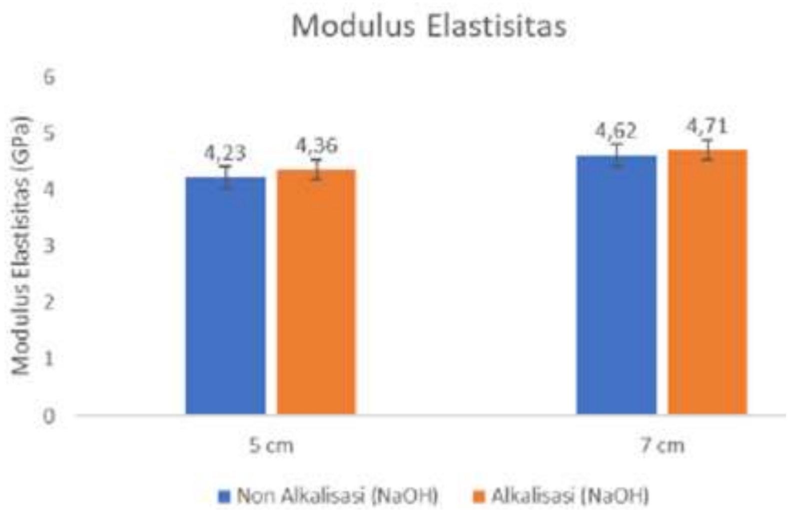


Figure 4. Graph of the Relationship Between Elasticity Modulus and Alkalinization and Non-Alkalization Treatment

The elastic modulus shows stiffness or resistance to elastic deformation. The greater the elastic modulus, the stiffer the banana tree stem fiber composite. From Figure 4, it can be seen that the tensile strength elastic modulus value for the alkalization treatment type has the highest average elastic modulus value, namely 4.71 GPa. However, there was a decrease in the variation in fiber length of 5 cm due to the binding capacity of banana tree midrib fibers with a poor matrix and the remaining lignin content which could affect the elastic modulus.

Scanning Electron Microscope (SEM) Test Results

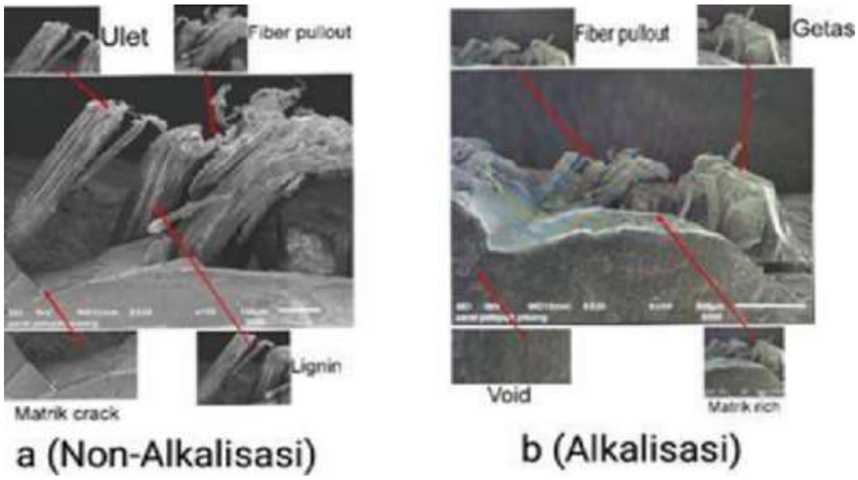


Figure 5. SEM Test Results of Composites and Kepok Banana Tree Fronds

It can be seen from the SEM photo results that the fracture with a fiber length variation of 5 cm without alkalisation shows a ductile fracture. This is because the matrix bond with the banana tree midrib fibers is very strong, resulting in a high tensile strength value. In the figure there are several factors that influence the occurrence of fracture failure in composites, namely the presence of fiber pullout and debonding. Fiber pullout is a broken condition where the fibers come out or are separated from the matrix, while debonding is damage that occurs to the composite caused by a lack of bond between the matrix and the fibers. This is because there is still a layer of wax, hemicellulose or dirt on the fiber. Voids that arise are caused by a lack of emphasis during the composite manufacturing process, thus initiating weaknesses in the composite structure. This fracture phenomenon can occur because the most dominant thing is cracks.

It can be seen in Figure 5b that the SEM test results show the failure of the composite material which is brittle, this is due to, among other things, the composite drying process being less than perfect due to the unequal mixture of the matrix and catalyst. In certain parts of the composite, it will have a hard structure but will have brittle properties. There are fewer defects in short fibers than in long fibers, so the tensile strength of long fiber composites will be smaller. This phenomenon occurs because the matrix does not completely wet the fibers so that the interfacial adhesion between the fibers and the matrix does not produce the expected bond. [9]

CONCLUSIONS AND RECOMMENDATIONS

From the results of research that has been carried out on composite materials using kapok banana tree frond fibers with an epoxy matrix with variations in fiber length, it can be concluded as follows:

1. The tensile test results showed that the average value of the most optimal composite tensile strength occurred at variations in length and 5 cm with alkalization treatment, namely 39.54 MPa. Meanwhile, the lowest average value of composite tensile strength occurred at length variations of 7 cm, this was due to defects occurring in the composite part due to the perfect tick matrix wetting the fibers.Pada hasil pengujian SEM variasi panjang serat 5cm non alkalisasi dengan kekuatan Tarik 39,19 MPa terlihat fiber pullout dan debonding dan matrik crak karena danya kegagalan yang pada saat proses pembuatan komposit.
2. Voids that appear in the composite cause the tensile strength to decrease because the matrix is unable to bind the fibers perfectly. Based on research on banana leaf midrib fiber composite testing that has been carried out, it was concluded that the alkalization treatment was able to increase the tensile strength of the composite specimen. The level of accuracy in the process of making composite specimens needs to be paid attention to in order to avoid air bubbles (voids).

FURTHER STUDY

This research still has limitations, so further research is needed related to the topic of Effect of Fiber Length and Alkalization Treatment on the Tensile Properties of Musa Paradisia Banan Stick Fiber Composite in order to perfect this research and increase insight for readers.

REFERENCES

Amellia dkk, 2023, "Analisis Limbah Serat Pelepah Pisang untuk dijadikan Bahan

Bakri, 2011, "Tinjauan Aplikasi Serat Sabut Kelapa sebagai Penguat Material Komposit, Jurnal Mekanikal", Vol. 2, No. 1, ISSN 2086-3403, 10-15

Hossen, M. F. (2011) "Biocomposite Reinforced With Natural Fibers 2000-2010", progress in Polymer Science, 37 (11), PP, 1552-1596.

Irwan, A., & Kurniawan, F, A (2020). "Penyelidikan Sifat Mekanis Bahan Komposit Polimer Diperkuat Serat Batang Pisang Kepok Akibat Beban Tarik". Jurnal Simentri Rekayasa, 2(2), 97-102

KR dan S, Dixit, "Tinjauan-Aspek masa depan komposit yang diperkuat serat alami" Polim. Memperbarui, Sumber Daya Jilid, 7, tidak 2, hal. 43-59, 2016. Doi: 10.1177/204124791600700202.

Maulida. 2006, "Perbandingan Kekuatan Tarik Komposit Polipropilena Dengan Pengisi Serat Pandan dan Serat Batang Pisang". Jurnal Teknologi Proses 5(2) Juli 2006 : 148-150, ISSN 1412-7814: 151-153.

Pendukung Komposit Fiber Terhadap Uji Tarik, Journal of Student Research (JSR)", Vol. 1, No. 4, e-ISSN: 2963-9697; p-ISSN: 2963-9859, Hal 138-147

Pramono, C., & Widodo, S. (2020). "Pengaruh Perlakuan Alkali Kadar 5% denagn Lama Perendaman 0 jam, 2 jam, 4 jam, 6 jam terhadap Sifat Tarik Serat Pelepah Pisang Kepok". Penelitian Inovsi: vl. 37 No. 1: 1-13http. Jurnal. Utm. Ac. Id/index, rhp/jpi/article/view/22/2020

SD Salman, "Sifat fisik, mekanik dan balistik serat knaf yang diperkuat poli vinil butiran dan komposit hibridanya," dalam komposit Vinyl Ester dan Polimer Vinil yang Diperkuat Serat Alami. Pengembangan, Karakterisasi dan Aplikasi, Cambridge, Inggris: Woolhead Publishing, 2018, hlm 249-263

Thoitullah, M. (2020). "Pengaruh Variasi Lama Perendaman Serat Terhadap Kekuatan Tarik Komposit Polieter Berpenguat Serat Pelepah Pisang Kepok (doctoral dessertation Institut Teknologi Kalimantan)