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Mechanical Properties of King Pineapple Fiber (Agave Cantula Roxb) As A Result of Fumigation Treatment

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ABSTRACT

The purpose of this study was to determine the effect of king pineapple fiber fumigation treatment toward the fiber mechanical properties. Fiber that has been parsed and cleaned with distilled water and then dried in an oven at a temperature of 60°C and at pH 7.King Pineapple fiber treated with fumigation in atreatment box where the smoke was produced from burning coconut shells in the drum and produces fumes and were piped into the fiber fumigation box continuously at an average temperature of 45°C with a fumigation time variation of 5 hours, 10 hours, 15 hours and 20 hours.The King Pineapple fiber who has gone through the fumigation treatment and the other part of the fiber sample that without treatment fumigation has then grouped and then performed a series of tests, namely: the composition test, the FT-IR test, the SEM test and a single fiber tensile test to determine the fiber chemical and mechanical properties before and after been fumigated. The results study of the single fiber tensile test showed that fumigation treatment would significantly affect the fiber mechanical strength.The fiber tensile stress without fumigation is about 188.74 MPa and the fiber undergo with fumigation for 15 hours has a tensile stress of 738.61 MPa.

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INTRODUCTION

Science and Technology Developments today were raising quite rapidly, both in metal and non-metal materials, wherein the metal material were dominatedby the industry. Excessive dependence on the metal material will lead to problems that depletion of the availability of materials mineral mining and environmental issues.

With the problems arise it is needed a development alternative to replacement the metal material. As an alternative material, namely the use of natural cellulosic fibers that are lighter, malleable, corrosion resistant, low prices, but their use is still lacking due to the mechanical properties of natural fibers reliability is still questionable.

One of the natural cellulose fibers that has been known for a long time by the people in Tana Toraja, South Sulawesi Province is the king pineapple fiber (Agave Cantula Roxb) which grows naturally and in the past the king pineapple fiber taken as rigging raw material, clothing or fabrics mainly as bodies wrapping because this king pineapple fiber is strong and long-lasting for hundreds of years when the fibers is undergo for fumigation.

According Wielage (2003) it is necessary to treat the fiber surface to get a better fiber mechanical property and a better adhesion strength considering that the cellulose-based natural fiber has an opposite hydrophilic properties compare with epoxy matrix which has a hydrophobic property.

The fiber surface treatment is expected to repair the fiber surface wettability properties and fiber adhesion (adhesion bonding) to the matrix. But, something could be keep in mind, according Drzal (1999) in the material sizing selection it is not allowed for the fiber to be mechanically degradation which is the material infiltration process into the pores surely does not cause a fiber surface damage that would lowered the fiber mechanical strength.

Macro-mechanicallythe natural fiber utilization either as an reinforcement or as filler in a form of layered composite, hybrid or sandwich with a variety of types, rapidly been developed for structural applications, but a fundamental understanding of the direct interaction between the natural cellulose fibers and matrices to observe compatibility includes mechanical properties, chemical reinforcement of composite materials, either in the form of fibers or particles have not been studied in depth because of

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the selection of the fiber material should also be compatible with the matrix material in order to obtain the ability of adhesion between the fiber - matrix more effectively.

Based on the brief description above it is carried out a natural fiber research, especially king pineapple cellulose fibers (Agave Cantula Roxb) with a fumigation treatment where the fumigation method used is the king of pineapple fibers is through burning coconut shells in a drum so that the smoke which contains phenolic compounds, carbonyl and other compounds.The treated king pineapple fiber was then observe by a composition test, FT-IR test, SEM test and a single fiber tensile test to determine the chemical and mechanical properties of the fiber before and after been fumigated.

The specific objective of this research is to determine the mechanical properties of the king pineapple fiber (Agave Cantula Roxb) which being subjected to fumigation. For the long term, this research aims to overcome the dependence of metal materials, overcomethe environmental pollution and encourage people the increased the use of cellulose natural fibers which are abundant and of course would impact the national economic growth.

Research Methods:

Materials used in this study is the king pineapple fiber leave taken from the king pineapple fields in TanaToraja district South Sulawesi province with an average age of 11 months. The first step is immersing the king pineapple leave a drum for three weeks to rotten the king pineapple leave. Furthermore, the fiber is then separated from the rotted leaves skin and then cleaned with distilled water, then dried in an oven at a temperature of 60°C and pH of 7.

The next step is treating the king pineapple fiber with a fumigation treatment in a certain box and fumigated through the burning of coconut shells in the drum and the fumes were piped into the fumigation box continuouslyat an average temperature of 45 °C with a fiber fumigation time variation respectively 5 hours, 10 hours, 15 hours and 20 hours. Fibers without fumigation and fibers that have been fumigated were then passing a series of tests, namely: the composition test, the FT-IR test, the SEM test and the single fiber tensile test to determine the fiber chemical, physical and mechanical properties.

RESULTS AND DISCUSSION

The composition test is to determine the fiber hemicellulose, cellulose, lignin, composition density and water content. The king pineapple fiber density value increases under a longer fumigation time (Figure 1) .

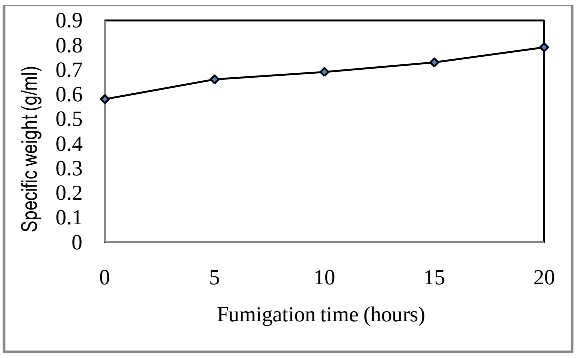

Fig. 1: Specific weight vs Fumigation time.

Figure 2 shows the KPF hydrolysis test results which is indicating the water levels decrease along with the fumigation duration time, this is due to the KPF evaporation resulting a dry KPF, so that the KPF surface wrinkle and the KPF cross-section shrink.

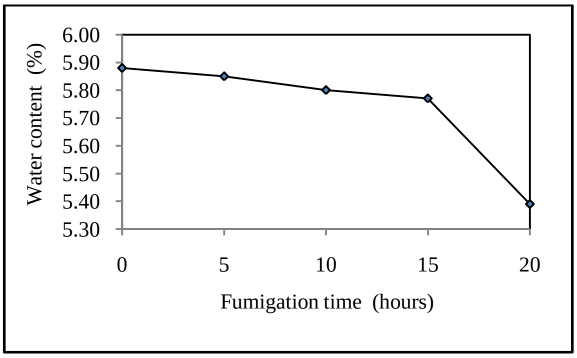

Fig. 2: Water content vs Fumigation time.

There is no significant change in the hemicellulose, cellulose, lignin content except there is an increase on 5 hours fumigation time (Figure 3) and decreased after a subsequent fumigation process. This is possible because on the fumigation process a chemical process occurs that allows the change in the concentration of these three components.

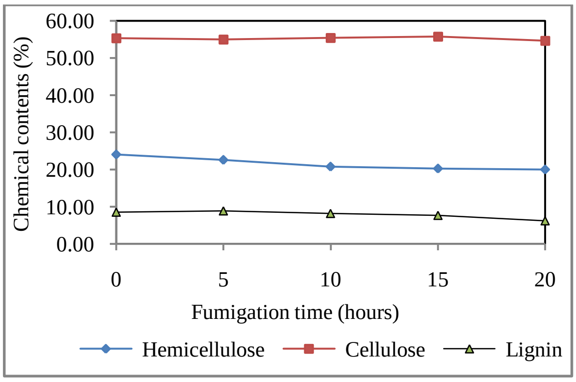

Fig. 3: Chemical contents vs Fumigation time.

From the king pineapple fiber FT-IR test result it is shown that normal fibers does not contain high levels of carbon (zero), after a fumigation process carbon levels rose sharply in the 5 hours fumigation time and would then relatively constant for the further fumigation time. The carbon dioxide (CO_2) increased in fumigated fibers could happen because the cellulose fiber has a high absorption nature. Carbon is absorbed primarily from carbon dioxide in (Figure 4).

Based on the FT-IR spectra there were a significant changePs in the vibration area of the –OH functional groups (the area between the wave number of 3000-3500 cm^{-1}). On the fiber sample without fumigation treatment a peak free OH absorption was given on a wave number area of about 3000 cm^{-1}.The characteristic vibrational spectrum range of free -OH group is strong but not dilated. The peak vibration range of -OH group began to widen on the king pineapple fiber fumigated for 5 hours, the same absorption peaks occur in a fumigation treatment under a longer treatment time (5 hours, 10 hours, 15 hours and 20 hours).

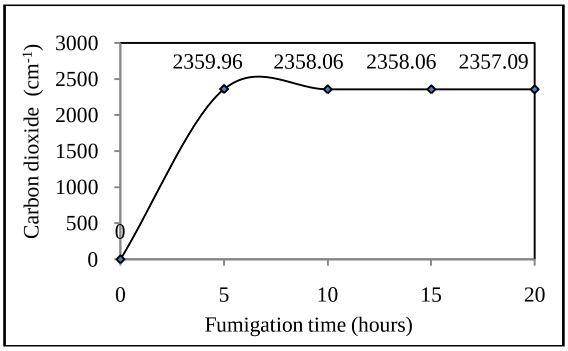

Fig. 4: Carbon dioxide vs Fumigation time.

The IR spectrum peak absorption extends to the wave area number of 3000-3500 $cm^{-1}$and is the vibration characteristic of bound -OH group. It shows there is a change in the functional groups of the cellulose king pineapple fiber fumigated chain. -OH bound was found at the carboxylic acid group (-COOH). So there is a great possibility that an oxidation reaction occurs in the side chains of the fiber cellulose form a carboxylic group. So it can be concluded that the king pineapple fiber cellulose mechanical strength increase is due to the fumigation process that has a relation results with the carburizing occurrence which is the chemical reactions either on the gas phase or on the fiber surface that forming a deposit, as well as the mass transfer of the reactant gas in the pore network by convection or CO_2 diffusion.

The mechanical strength (tensile strength) increase occurs because the fumigation treatment would result a drier fiber, so that the lignin contained in the king pineapple fibers would strengthen the cellulose fibers bonds. As a result of drying it can lead to the pores formation which originally occupied by water molecules, the pores can be filled by CO_2molecules which was taken from the smoke. CO_2 occupied a smaller space than the space occupied by water (H_2O) molecules. The CO_2 structure has a straight-shaped molecular structure whereas H_2O has a bent shaped molecule. Of course, not all of the pores left by H_2O molecules are filled with CO_2 molecules. This situation is supported by the SEM image data where fiber without fumigation has no pores as shown in (Figure 5), while the cross-section of the fiber due to the fumigation in (Figure 6), appearsthat the fiber are to be more tightly and the pores become open. The longer the fumigation time the pores seem to be more open and the cellulose fibers become tighter.

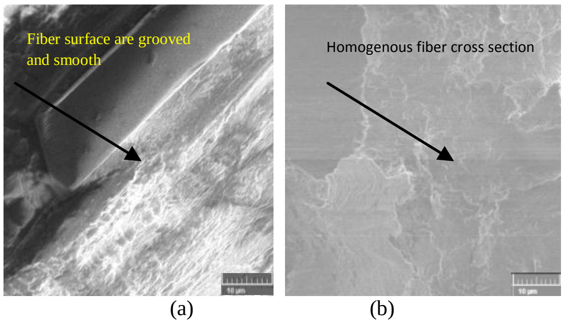

Fig. 5: Fiber Surface SEM photo (a) Fiber cross-section (b) without fumigation

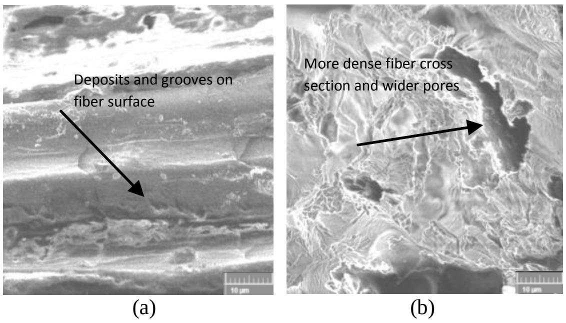

Fig. 6:Fiber Surface SEM photo (a) Fiber cross section(b) 20 hours fumigation

The side chain oxidized could strengthen the secondary bonding between the fiber cellulose chains, because carboxylic groups can form hydrogen bonds between molecules. In addition, the carboxylic group on the side chain can form a crosslinked cellulose or cross position between the cellulose chain. All bonds can increase the tensile strength of the king pineapple fiber as shown in Figure 7, which is the result of a single base leave king pineapple fiber tensile test.

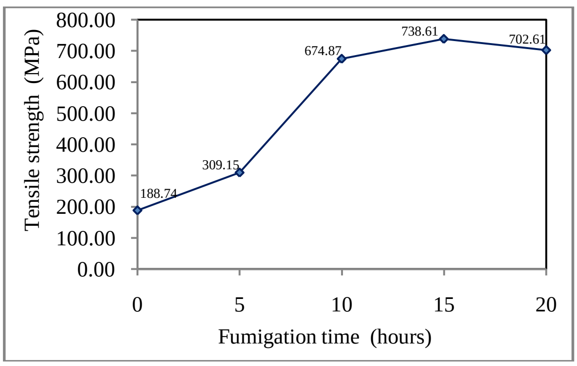

Fig. 7: Tensile strength vs Fumigation time.

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***Conclusion*:**

Based on the research that has been done, it can be concluded that the king pineapple fiber is potentially to be used as reinforcement in a composite after a fumigation treatment because:

1. Fumigation treatment can alter the king pineapple fiber surface morphology shape becomes drier and perforated, form pores in the king pineapple fiber cross section.
2. On the king pineapple fumigation treatment a carburizing process occurs which is the chemical reaction in the gas phase on the fiber surface that makes up the deposit, as well as the mass transfer of the reactant gas in the pore network by convection or CO_2 diffusion starts from 0 to 2359.96 cm^{-1}, so that the fibers tensile strength increased.
3. The king pineapple fiber base side without any fumigation process tensile stress is as big as 188.74 MPa and king pineapple leave base fumigated fiber increased in line with the fumigation duration time, namely the tensile under a 15 hours fumigation treatment is as big as 738.61 MPa.

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REFERENCES

Vivian, P.,Cyras, Claudia Vallo, Jose M. Kenny, AnaliaVazques, 2004."Effect of Chemical Treatment on the Mechanical Properties of Starch-based Blends Reinforced Sisal Fiber", Journal of Composite Materials, 38(16): 1387-1399.

Pradeep, K.,Khushwaha, Rakesh Kumar, 2010. "Effect of Silanes on Mechanical Properties of Bamboo Fiber-epoxy Composites", Journal of Reinforced Plastics and Composites, 29(5): 718-724.

Marsyahyo, Eko, 2009. "Investigation Of Chemical Surface Treatment of Rami Fiber (Boehmerianivea) on Surface Morphology, Tensile Strength an Single Fiber Fracture Modes, Universitas Gajah Mada.

Alexandre Gomes, Takanori Matsuo, Koichi Goda, JunjiOhgi, 2007. "Development and Effect of Alkali Treatment on Tensile Properties of Curaua Fiber Green", (10) Composites Journal

Berthelot, J.M., 1999."Composite Materials: Mechanical Behavior and Structure Analysis"Springer-Verlag, New York

Drzal, L.T., 2003. ASM Handbook: "Composite Interface, and Interphases", FB MVU, online:www.mb.hs_wismar.de/ interfaces.

Gibson, R.F., 1994. "Principles of Composite Material Mechanics, McGrawHill Int., Singapore

Lodeiro, M.J., 2001."Single Fiber Fragmentation Test for the Characterization of Interfacial Phenomena in PMCs", no MATC(MN)07, National Physic Laboratory, Crown copy right, UK.

Sergio, N., Monteiro, 2005. "Mechanical Strength of Polyester Composites Reinforced with Coconut Fiber Wastes", J.RevistaMateria, 10(4): 571 – 576.

Smith William, F.,1999."Principles of Material Science and Engineering', New York: Mc.Graw Hill Book Company.

Vaseliev, V.V., E.V.Morozov, 2001."Mechanics and Analysis Composite Materials", Elsevier science

Waifilate, Afa Austin, 2008. "Mechanical Property Evaluation of Coconut Fiber", Sweden: Department of Mechanical Engineering,Blekinge Institute of Technology.

Wielage, B.; Lampke, Th. Utschick, H.; Soergel,F.: Processing of natural-fibre reinforced polymers and resulting dynamic - mechanical properties. Journal of Materials Processing Technology, Vol. 139 (2003) No.1-3, p. 14-146, ISSN 0924-0136

Wang Ning, Zhang Xingxiang, Han Na ang Fang Jianming, 2010."Effects of Water on the Properties of Thermoplastic Starch Poly(latic acid) Blend Containing Citric Acid", Journal of Thermoplastic Composite Materials.

Mehrer, H. 2007. Diffusion in solids, Fundamental, Methods,Materials, Diffusion – Controlled Processes, Springer-Verlag Berlin Heidelberg.

Bader, M.G., Hill., A.R., 1993, Short Fiber Composites: Structure and Properties of Composites, vol.13, Editor: Chou, T.W., Pen. VCH, Weinheim, Jerman.

Birkerland, Sveinung., Anna Maria BenczeRora., Torstein Skera., Bjorn Bjerkeng. 2004. Effect of Cold Smoking Procedures and Raw Material Characteristicson Product Yield and Quality Parameters of Cold Smoked Atlantic Salmon (Salmonsalar L.) Fillets. Food Research International 37:273–286.

Mahato, D. N., R. N. Prasad, and B. K. Mathur. 2009. Surface morphological, band and lattice structural studies of cellulosic fiber coir under mercerization by ESCA, IR and XRD techniques. Indian Journal of Pure & Applied Physics 47: 643–647.

Silva, F.A., Mobasher, B.,Soranakom, C.,Filho, R.D.T.,et.al., 2011,"Effect of Fiber Shape and Morphology on Interfacial Bond and Cracking Behaviors of Sisal Fiber Cement Based Composites" , Cement and concrete composites, 33:814-823.

Khalil, H.P.S.A., Alwani, M.S., Omar, A.K.M. 2006. Chemical Composition, Lignin Distribution, and Cell Wall Structure of Malaysian Plant Waste Fibers.J.Bioresources 1 (2): 220-232.

Nibu, A. G. and R. Vinayakrishnan, 2002, Photo acoustic evaluation of thermal diffusivity of coconut shell, *J. Phys.: Conders. Matter*, Vol. 14, pp. 4509 – 4513.