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EFFECT OF TURMERIC (*CURCUMAE LONGAE*) TREATMENT ON MORPHOLOGY AND CHEMICAL PROPERTIES OF AKAA *(CORYPHA*) SINGLE FIBER

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Abstract

The study is to determine the ingredients effect the turmeric (Curcumae longae) treatment of Akaa (Corypha) midrib fiber, toward the surface morphology and chemical properties. The material used was a natural fibers, soaking in water 1 hour, by heating a turmeric solution 1 hour (TT1), 2 hours and 3 hours. The heating of 86°C - 90°C at 1 atmosphere pressure, and dried of 28°C-32°C at 48 hours. The turmeric solution was turmeric powder 20% and water 80% in volume. The surface morphology and the roughness was tested by scanning electron microscope and the roughness test. The chemical properties by hidrolisis and the X-Ray diffraction test. The results, that changing of the fiber surface morphology and the roughness decrease after treatment. The TT1 treatment increases the cellulose 22% and reduced the lignin 42%, also the sharpest peak diffraction pattern which was indicated an increases on the crystal level.

Keywords: Fibers, turmeric, surface morphology, chemical properties.

1. Introduction

Engineering is very rapidly developed recently today in the context of the composite materials development as an alternative technique appropriate with the material application.

One of the engineering and technical innovations was taking the advantage of natural fibers as the reinforcement of composite materials. Natural fibers were chosen

Nomenclatures

AT	Soaked with distilled water for one hour of single fiber
I(am)	Amorph intensity
$I_{(002)}$	Maximum intensity
I_c *(%)*	Crystallization index value
NT	Non treatment single fiber
TT1	Turmeric treatment for one hour
TT2	Turmeric treatment for two hours

Abbreviations

EDS	Energy Dispersive X-Ray Spectroscopy
SEM	Scanning Electron Microscope
XRD	X-Ray Diffraction

chosen because they have the advantage that can be recycled and are environmentally friendly. Natural fibers are the bamboo fiber, hemp, banana, coconut fiber, pineapple and palm [1].

The natural fibers main contents were lignocellulose namely cellulose, hemicellulose, and lignin [2]. The natural fiber lignocellulose percentage content was depending on the location conditions and the climate where they were grown. Cellulose and hemicellulose was a polysaccharide compound while lignin compounds are polyphenols macromolecular compounds [3]. Similarly, the hydrophilic characteristic was one of the properties owned by natural fibers [1, 2, 4]. To improve the compatibility of natural fibers that is hydrophilic done in methods, that physical treatment or chemical treatment with the aim of getting the strength or ductility better.

Chemical treatment is one solution to improve the properties of natural fibers such as improved fiber strength, fiber surface shape, remove impurities, and improve the interaction between the fiber and the matrix [5]

Changes in rough fiber surface can be done by means of alkali treatment is reduced aggression fibers. Alkali treatment is a chemical treatment which removes most hemicellulose, lignin, wax, and oil -soluble alkali [6]. So that the alkaline solution is a chemical commonly used as initial treatment of the fiber.

Seen by many research, the scientists used an alkali solution as a pre-treatment of the fiber [6 - 9]. Kalium Permanganate ($KMnO_4$) is another medium which is also a chemical treatment which serves to provide the fiber surface repairs and improvements of mechanical properties. Is an alternative media to raise the mechanical properties of the composite are better [10].

Similarly, to reduce the fiber water content for increasing the single fiber tensile strength, the fiber was treated with a hydrogen peroxide (H_2O_2) solution of with various concentrations [11, 12]. The research with NaOH pre-treatment and continue with KMnO4 and a second study with a NaOH and treat further with KMnO4 and lastly treat with H_2O_2 further would improve the fiber morphology shape [2]. Besides chemical treatment, a treatment by washing and heated the fiber can remove the fiber surface dirt so that fiber cavity occurs [2, 13]. Therefore,

should be considered to increase the strength composite natural fibers with fiber surface modification method [14].

The pre-treatment as mentioned above was done chemically giving the impression that by using natural ingredients such as turmeric (Curcumae longae) has not been done by previous researchers. Turmeric was an environmentally friendly plant that has a lot of substances that can be used. One of the curcuma content was the atsiri oil which could kill bacteria and inhibit the growth of vegetative bacillus cells so that the fiber would well preserved and clean from bacteria. Turmeric solution was a cellulose acid compound and functioned to raise cellulose and lower the partly lignin and would affect the fiber mechanical properties, especially fiber tensile strength fiber [1]. Then a chemical pretreatment and heated treatment on natural fibers can make crystals on the fiber [2]. This study chose natural fibers are fibers Akaa midrib. With pretreatment of the fiber was heated on natural ingredients such as turmeric solution. And this study aimed to establish the effect of treatment of the fiber was heated in a solution of turmeric to the surface morphology and chemical properties.

2. Experimental

2.1. Materials

Material used in this study was the Akaa midrib fiber *(Corypha*), a turmeric solution (*Curcuma longae*) and distilled water. Akaa midrib fiber obtained from Akaa plant that grows in the Wajo South Sulawesi Province of Indonesia area. Akaa midrib fiber processed manually pounded by using a rubber mallet to take the fibers outside. Fiber was taken by unplugging manually (NT). First was by soaking the Akaa midrib fibers in distilled water for 1 hour (AT), secondly, treatment on the fiber by heating it in a turmeric for 1 hour (TT1), 2 hours (TT2) and 3 hours (TT3). The heating temperature variation was 86 °C – 90 °C under a 1 atmosphere pressure. After that, all the fibers were dried at room temperature of 28 °C – 32 °C for about 48 hours. The turmeric solution was prepared with a turmeric powder concentration of 20% and 80% of distilled water in a unit volume.

2.2. Methods

The fiber surface morphology was examined using the Scanning Electron Microscope (SEM). Samples were cut in pieces and placed on the preparations. The samples were observed with the Vega3 Tescan at a 5 kV voltage until the surface morphology seen appears on the screen. By using the Mitutoyo SJ.301 roughness test, the surface roughness could be determined with the form of graphs and figures roughness. The hydrolysis test was a test to determine the hemicellulose composition percentage, cellulose, and lignin. The method used was a "Chesson" method, which is using sulfuric acid (H_2SO_4) as the media. Sulfuric acid was used to hydrolyze cellulose and other polysaccharides. Lignin was washed and filtered, after that been ash and then weighed. The further test was the XRD (X-Ray Diffraction) made by Rigaku. Mashed fiber sample was placed on a tray which is then inserted into the apparatus. The test results were in the form of graphs and crystallization index value figures. Like wish can be

differentiate between the material that is crystalline or amorphous in the fiber before and after treatment.

3. Result and Discussion

From the SEM in Fig. 1 the results showed the fiber surface morphology, either the untreated fiber or the fiber treated. It was seen that the untreated fiber morphology shows the occurrence of lignin, wax, dirt, and low adhesion substances shaped as granules were attached on the fiber. The fiber treated by soaking in distilled water (AT) appeared somewhat clean fiber morphology due to the lignin reduced, dirt and low adhesion substances even there was no fiber flakes. Then the fiber with a 1 hour (TT1) heated treatment in a turmeric solution fiber has a clean surface, coarse, a clean deep grooves, hollow even seen protrusions on the fiber. Coarse fiber surface and the protrusion is one of the effects of fiber heated. The bugle is indicative of the occurrence of crystallization [2]. It appears also treated fibers are heated in a turmeric solution for 1 hour and 2 hours produces the best fiber morphology. Such treatment was the maximum time for Akaa fiber cells to absorb various oxide atoms contained in the solution [1].

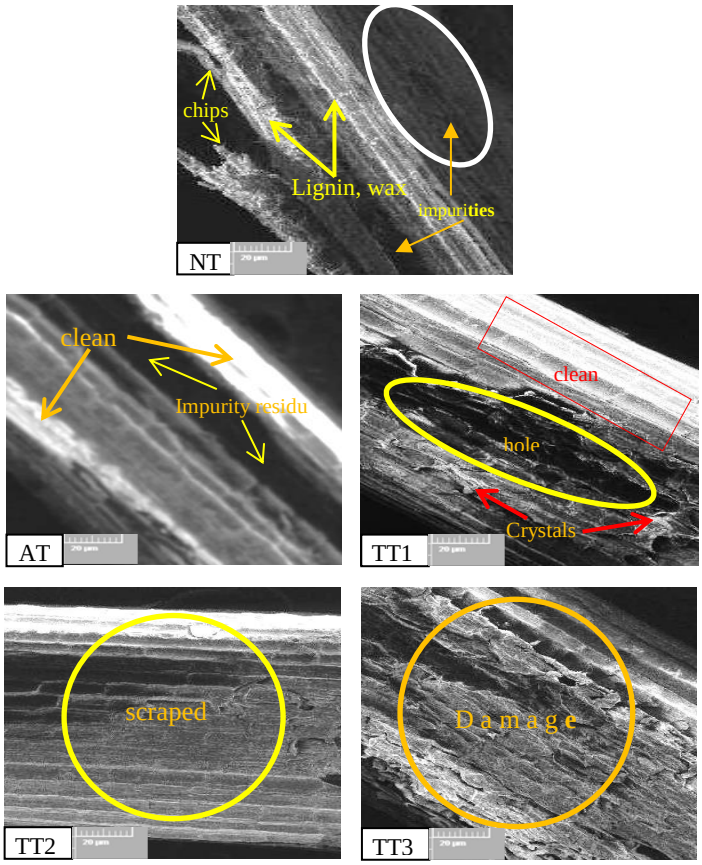

Fig. 1. SEM Photographs of Akaa fiber[15].

However, on the TT2 treatment, it was obvious, from the SEM results that the fiber began to erode. So it can be concluded the TT1 treatment was still better than TT2 treatment. Similarly, on the TT3 treatment result, it was seen a number of fiber cells damaged, the fiber morphology was no longer homogeneous, the oxide or atomic Akaa fiber absorption ability decreased. The fiber morphology plays an important role on the fiber mechanical properties such as the stress and strain achieved by the Akaa fiber. Good fiber morphology indicating a good fiber mechanical property [1].

The fiber roughness test is shown in Fig. 2. The results showed that the Akaa midrib NT and AT treatment has the lowest roughness of all treatments carried out. It was caused by the surface of the fiber was still in blanket of the lignin, wax as visible result of SEM. It was also agree with wax test results on the Scanning Electron Microscopy with Energy Dispersive X-Ray Spectroscopy (SEM - EDS). As shown in Fig. 3, it is still contained in the matter of exposure to low adhesion substances [1]. So that when the surface roughness test was done, lignin, wax and such substances recorded make the fibers appear very smooth. For the fiber treated in hot turmeric solution for 1 hour (TT1) increase the surface roughness compared with previous treatments NT and AT. There to caused by fiber surface was clean, rough, making deep and clean grooves, hollow even appear bumps on the fiber as test results SEM.

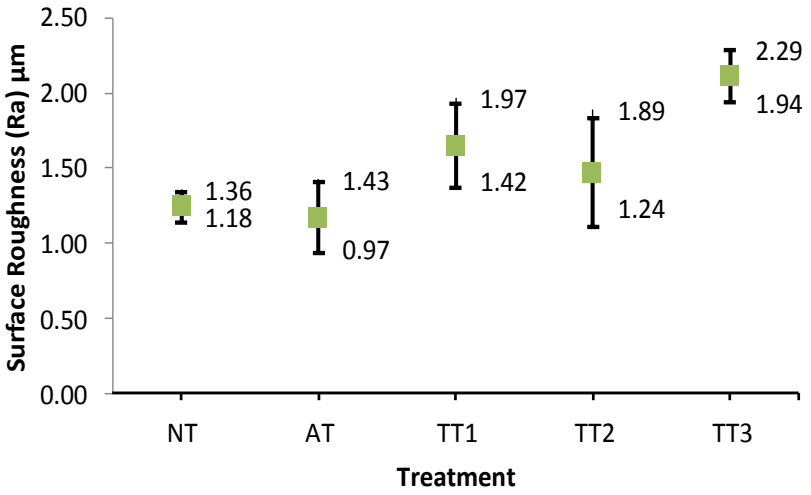

Fig. 2. Akaa fiber surface roughness.

Then the roughness decreases to the TT2 treatment, the TT2 condition closely related to the condition that the TT2 fiber treatment fibers start to be eroded (SEM results) and the low adhesion substances begin to adhere back and this was match with the SEM –EDS result as seen in Fig. 3 [1].

So that substances attached to the fiber surface making the surface less rough than the current TT1 test surface roughness. Other things, different on the TT3 treatment which was increases the fiber surface roughness. There to caused by fiber that were not homogenous again and number of fiber from cell damage. So at the time in a test surface roughness recorded. Roughness was damaged due to

conditions of fiber and was not homogeneous. Roughness even increased but cannot declare that the figures in the best roughness. TT1 treated is the best.

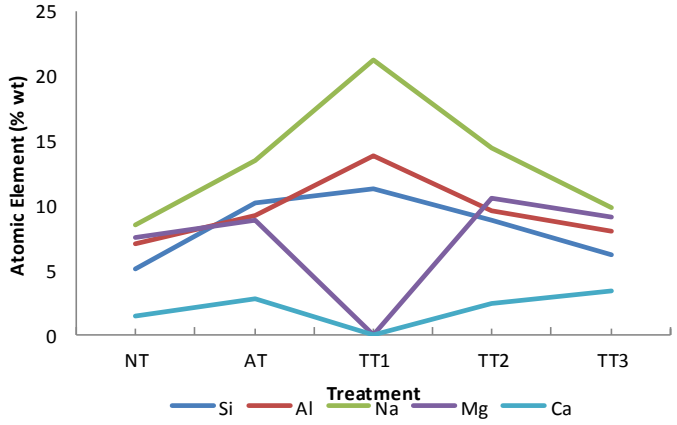

Fig. 3. EDS test result [1].

From Fig. 4 the results showed the composition of hemicellulose; Akaa frond fibers NT has 24.12% and then increased on the AT treatment 28.24%, and then decreased on TT1 treatment 25.32%, on the TT2 (22.12%) and the TT3 20.55%. For the cellulose composition on the NT treatment has 33.28%. At the AT treatment it increased to 35.95% and increased again on the TT1 to 40.61% and decreased on the TT2 to 32.55% and the TT3 31.77%. Furthermore, for the lignin composition on the NT has 25.40%, and on the AT treatment increased 25.89% and then decreased to 14.82% on the TT1 treatment and then increased to 21.95% in TT2 and increased to 24.10% on TT3. There to can be declared that from the fiber of Akaa without treatment (NT) and then to be heated in the a turmeric solution for 1 hour (TT1) increased the cellulose compounds 22% and decreased the lignin 42%. That is the highest procentate of cellulose and lowest lignin procentation for all of the treatments. Cellulosa with high strength and style chain between the chain due to hydrogen bonding between the hydroxyl groups of adjacent chains causes high crystal [2]. The crystallization happen because cellulose compounds. The celluloce compound is the crystal compound. So that if the cellulose increased will the crystalline characteristic raised too.

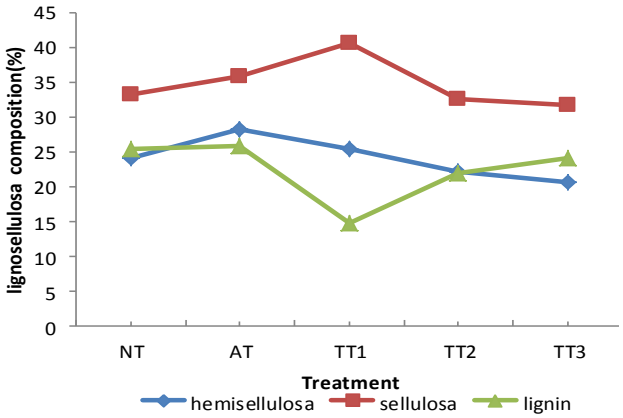

Fig. 4. Result of hidrolisis test of Akaa fiber.

Figure 5 shows that the Akaa fiber test result diagram for a variety of treatments using X-rays or X-Ray diffraction angle 2θ range of 10-70^0 which shows the peak difference of each fiber with different treatments. The TT1 peak diffraction pattern at an angle of 22° appears to have the sharpest angle or has the highest compared with the NT, AT, TT2 and TT3 treatments. This was an indication that the sample had the highest level of crystallization or the best cells regularity. These results were consistent with the results of other measurement techniques, namely the crystallization index calculation as in Table 1 where the crystallization index TT1 is the highest compared to other treatments. The crystallization exists on the Akaa fiber stem that looks like bulges as also seen in the SEM photo results. The crystallization in TT1 treatment was due to the increased of cellulose compound that was a crystalline compound.

Table 1. Crystallization index value.

Treatment	$I_{(am)}$	$I_{(002)}$	I_c (%)
NT	2,700.00	4,540.00	40.53
AT	3,006.67	5,156.67	41.69
TT1	3,443.33	6,560.00	47.51
TT2	3,048.33	5,100.00	40.23
TT3	3,366.67	5,723.33	41.18

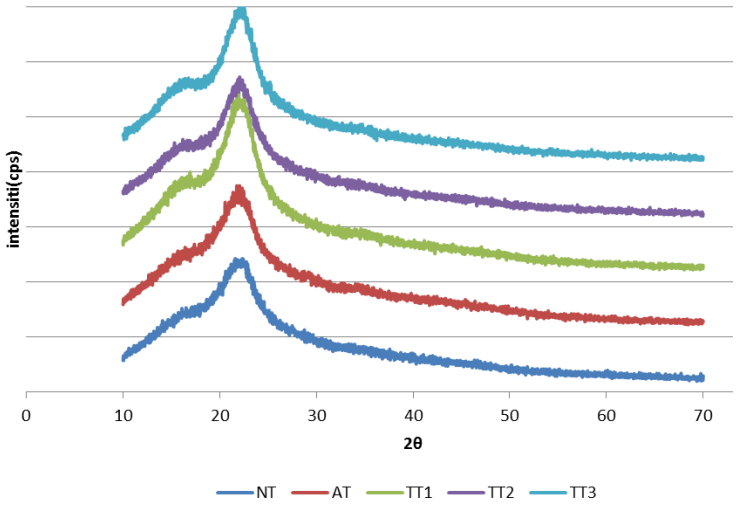

Fig. 5. XRD examination result.

4. Conclusion

Based on the previous description of the Akaa frond fibers treatment heated in a turmeric solution, it can be concluded that:

- The fiber treatment heated on a turmeric solution can change the fiber surface morphology shape and the Akaa midrib fiber become rougher, cleaner, and emerging forms of protrusions.
- The fiber treatment heated in a turmeric solution can increase the cellulose and decreased the lignin while hemicellulose level was almost constant.

- The fiber treatment heated in a turmeric solution for 1 hour made the top of the pattern diffraction reproof is indication thus level crystal on the fiber surface caused increasing the compound cellulose because the cellulose compound is the crystal compound.

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References

1. Renreng, I.; Soenoko, R.; Pratikto.; and Irawan, Y.S. (2015). Effect of turmeric (curcuma longae) treatment toward the single fiber akaa (corypha) tensile strength. *International Journal of Applied Engineering Research*, 10(12), 31213-31222.
2. Arsyad, M.; Wardana, I.N.G.; Pratikto; and Irawan, Y.S. (2014). The morphology of coconut fiber surface under chemical treatment. *Revista Materia*, 20(1), 172-180.
3. Muensri, P.; Kunanopparat, T.; Menut, P.; and Siriwattanayotin, S. (2011). Effect of lignin removal on the properties of coconut coir fiber/wheat gluten bio-composite. *Composites Part A: Applied Science and Manufacturing*, 42 (2), 173-179.
4. Dixit, S.; and Verma, P. (2012). The effect of surface modification on the water absorption behaviour of coir fibers. *Advances in Applied Science Research*, 3(3), 1463-1465.
5. Ahad, N.A.; Parimin, N.; Mahmed, N.; Ibrahim, S.S.; Nizzam, K.; and Ho, Y.M. (2009). Effect of chemical treatment on the surface of natural fiber. *Journal of Nuclear and Related Technologies*, 6(1), 155-158.
6. Karthikeyan, A.; and Balamurugan, K. (2012). Effect of alkali treatment and fiber length on impact behaviour of coir fiber reinforced epoxy composites. *Journal of Scientific & Industrial Research*, 71, 627-631.
7. Karthikeyan, A.; Balamurugan, K.; and Kalpana, A. (2013). The new approach to improve the impact property fiber reinforced epoxy composites using sodium lauryl sulphate treatment. *Journal of Scientific & Industrial Research*, 72, 132-136.
8. Azmi, M.A.; Yusoff, M.F.C.; Abdullah, Z.A.; and Idris, M.I. (2012). Rigid polyurethane foam reinforced coconut fiber properties. *International Journal of Integrated Engineering*, 4(1), 11-15.
9. Carvalho, K.C.C.; Mulinari, D.R.; Voorwald, H.J.C.; and Cioffi, M.O.H. (2010). Chemical modification effect on the mechanical properties of HIPS/coconut fiber composites. *Bio resources*, 5(2), 1143-115.
10. Lai, C.Y.; Sapuan, S.M.; Ahmad, M.; Yahya, N.; and Dahlan, K.Z.H.M. (2005). Mechanical and electrical properties of coconut coir fiber-reinforced

polypropylene composites. *Polymer-plastics technology and engineering*, 44, 619-632.

11. Hussain, S.A.; Pandurangadu, V.; and Palanikuamr, K. (2011). Mechanical properties of green coconut fiber reinforced HDPE polymer composite. *International Journal of Engineering Science and Technology*, 3(11), 7942-7952.
12. Rosa, M.F.; Chiou, B.; Medeiros, E.S.; Wood, D.F.; Williams, T.G.; Mattoso, L.H.C.; Orts, W.J.; and Imam, S.H. (2009). Effect of fiber treatment on tensile and thermal properties of starch/ethylene vinyl alcohol copolymers/coir bio composites. *Bio resource Technology*, 100, 5196-5202.
13. Ferraz, J.M.; Menezzi, C.H.S.D.; Teixeira, D.E.; and Martins, S.A. (2011). Effect of treatment of coir fiber and cement/fiber ratio on properties of cement-bonded composites. *Bio resources*, 6(3), 3481-3492.
14. Mulinari, D.R.; Baptista, C.A.R.P.; Souza, J.V.C.; and Voorwald, H.J.C. (2011). Mechanical properties of coconut fibers reinforced polyester composites. *Procedia Engineering*, 10, 2074-2079.
15. Renreng, I.; Soenoko, R.; Pratikto.; and Irawan, Y.S. (2015). Effect of turmeric (curcuma) solution treatment toward the interfacial shear stress and wettability of a single fiber akaa (corypha) on epoxy matrix. *International Journal of Applied Engineering Research*, 10 (10), 26379-26390.