

Effect a Chemical Treatment of Pineapple Leaf Fiber (PALF) for Mechanical Properties as a Reinforced Composite Matrix Polyesters

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Abstract. Application of composite materials as a alternative materials is developed, The most of composite material is polymer matrix composite (PMC), with the polymer as a matrix and the sintetic fiber such as fiberglass and fiber carbon as a reinforced, it can make a materials with intermediete mechanical properties such as strength, hardness and thoughness, between matrix and fiber. Since the synthetic fiber was dangerous for human, so recently developing natural fiber composite with advantages of natural fiber is more environmentally friendly, and more cheap than synthetic fiber. Otherwise, natural fiber has stong enough when it use at interior automotive parts, such as dashboard. Some cars already use the natural fiber for the interior parts. The natural fiber has a big potential, especially pineapple in Indonesia, the pineapple production at East Kalimantan is 25 344 tonnes in 2014. It means a lot of leaves can be used for the natural fiber. Pineapple leaf fiber (Pineapple Leaf Fiber / PALF) has a pretty good tensile strength of 126 MPa, and Young modulus of 4405 MPa and has a cellulose content About a 70-80% cellulose, cellulose which has a crystalline structure, so it can be good reinforced for composite. The result of this experiment, the optimum value of tensile strength is 29.9648 MPa , at composite PALF – Alcalinitation 40%.

INTRODUCTION

Composite material to be an alternative material beside metals , ceramics, and polimers, Composite materials is a fusion of some materials, that had a different chemical properties and physical, so that had a new mechanical properties from source materials, the reinforce of composite usually fiberglass or fiber carbon. Application composit for alternatif materials beside metals or another materials has been done in various aspect, for example in automotive , application of composite materials for automotive industry are doorpanel, roof cover, dashboard and leather at car seat, and that useing a synthetic fiber such as fiberglass or fiber carbon. Composite reinforced synthetic fiber had some disadvantage, specially unfriendly with nature, difficult decomposed, and unfriendly with our body (Engineering360, n.d.). So that synthetic fiber should be replace by natural fiber. Natural fiber had more advantages, because its cheaper, more healty, and could be renewable . In 1999, Bledski and Gassan investigated natural fiber as a reinforced plastic, and 2008, development in automotive aspect starts from 2008 by John, in his study, he developpt natural fiber composite for aplication cover door panel, and roof cover (Panyasart, Chaiyut, Amornsakchai, & Santawitee, 2014). One of natural fiber can use is pineapple leaf fiber (PALF), it has good mechanical properties, tnesile strength 126MPa, modulus young 4405 Mpa (BPS Kaltim, 2015). In Borneo,production of pineapple good enough, that reached 25.344 ton in 2014, its means more leaves became waste (Kengkhetkit & Amornsakchai, 2012). Pineapple Leaf Fiber (PALF) contain 70-80 % celullulose. Thus cellulose had a crystalline structure, so mechanical properties of PALF were good (Devi, Bhagawan, & Thomas, 1997). Cellulose must be separated from another contain of fiber with some chemical treatment, such as alkaline treatment, and bleaching treatment. Alkaline treatment were using NaOH solution to eliminated hemicellulose and wax, and bleaching treatment using NaClO₂ to eliminated Lignin and some hemicellulose(Asim, Jawaid, Abdan, & Ishak, 2016).

Some study about PALF composite were promising in recent years, especially as a composite matrix polimer. Shih YF et.al. in 2012 using PALF with Polybutilane succianate as a matrix, and Polypropyhlane as a matrix was investigated in same year, in 2008, Wang KH study about PALF composit with Poly(lactidacid) as a matrix and

many more (Shih et al., 2014). In this study , experimental investigation were performed to determined the effect of chemical treatment on the mechanical properties of PALF composite with polyester matrix.

MATERIALS AND METHODS

Preparation of PALF

Pineapple leaf was found at Balikpapan KM 32nd, that leaves separate from the fiber. The fiber was dried at outside to decreasing moisture from fiber. Next step pineapple leaf fiber (PALF) was cut of 5 mm and ready to use. The ingredients of Pineapple Leaf Fiber at table below.

Table 1 : Ingredients of Pineapple Leaf Fiber

Composition	%
Cellulose	69,5-79,5
Pentose	17-17,8
Lignin	4-4,7
Pectin	1-1,2
(protein, organic acid ,wax dll)	<i>Balance</i>

Alkaline Treatment

Pineapple Leaf Fiber (PALF) from the previous preparation were immerge and stirred continuously in 10% NaOH solution at temperature 70°C for 4 hour. The weight ratio of NaOH solution per fiber was fixed at 20:1. Next the PALF was neutralized by aquadest until pH 7-8, and dried it at room temperatur for 24h.

Bleaching

Alkalinized Pineapple Leaf Fiber (PALF) from the alkaline treatment were immerge and stirred continuously in NaClO₂ 1.7% CH₃COOH 0,2 M as a buffer solution at temperature 80°C for 4 hour. The weight ratio of NaClO₂ 1.7% solution per fiber was fixed at 20:1. Next the PALF was neutralized by aquadest until pH 7-8, and dried it at room temperatur for 24h.

Composite Manufacturing

Three PALF i.e. untreated, alkaline treated, and bleaching treated, were dried before use. Tensile spesimen ASTM D 638 was molded by hand lay up method and the orientation of fiber was random short fiber composite. The variation of volume fraction was obtained, there was 20%, 30% and 40% for untreated, alkaline treated, and bleaching treated.

Tensile Strength

Tensile strength were determined with universal testing maching (SHIDMADZU) at Airlangga University, Surabaya. Tensile testing carried out following ASTM D 638 respectively. The mean value at least 3 speciment is repost for each property.

Morphology, Dispersion and Distribution of Fiber

Fractured surface were observed under an optical microscope PrimoStar, with total magnification is 63x. Morevoer, fractured surface wer observed under DSLR Camera with macro lens to obtained dispersion and distribution of fiber at composite.

RESULT AND DISCUSSION

Alkaline Treatment of PALF

Alkaline Treatment has been done to decrease wax and hemicelulose in pineapple leaf fibre in Fig. 1. These component were disadvantageous, becous it can made bond of fiber and matrix weaken. In this precess, wax and hemicelullose were dissolved with NaOH, so the contain of cellulose was actualy increase. Alkaline treatment can increase wettability and interface bonding between matrix and fiber grow up.



FIGURE 1. PALF after Alkaline Treatment

Bleaching Treatment of PALF

After alkaline tratment, next process was bleaching tratment, the purpose of bleaching tratment to degrade lignin and hemicelullose in pineapple leaf fiber (PALF) , so the cellulose content was increase. Cellulose had good mechanical properties and Crystalline, and it can effect increasing mechanical properties of composite.



FIGURE 2. PALF After bleaching treatment

Composite ManufacturingProcess

The short fiber composite were prepared with hand lay up method, and room temperatur. Composite were prepared following standard of specimen ASTM D 638 in Figure 3, every variation of this study were prepared 3 specimen.

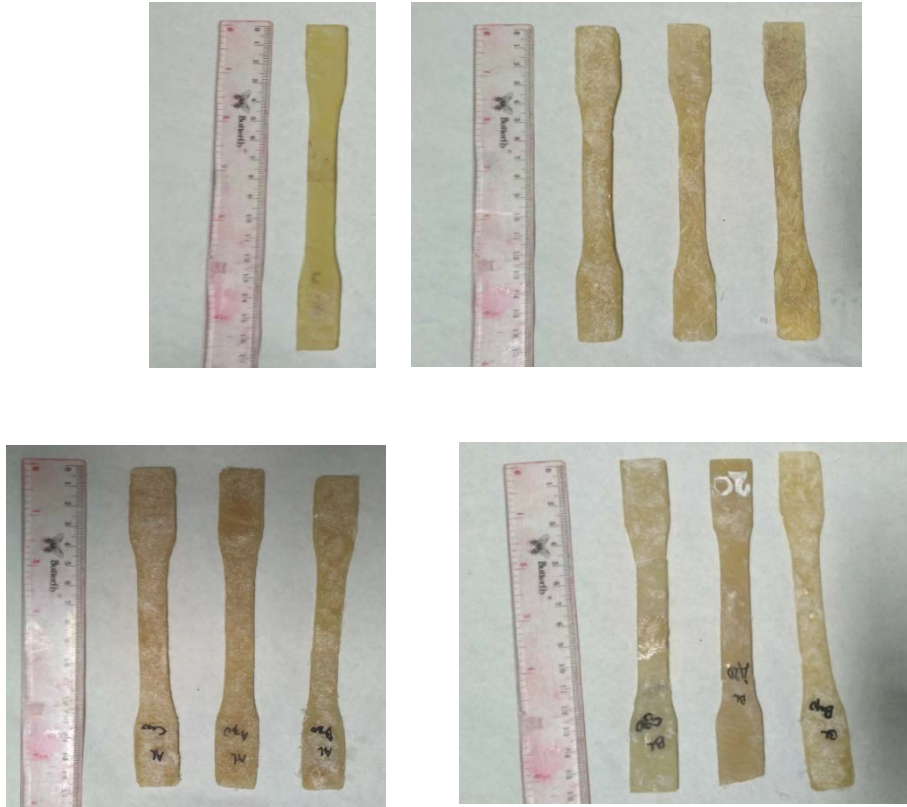


FIGURE 3. Tensile test specimen D 638 with Hand Lay Up Method

Tensile Properties of Composite

Tensile testing was observed to know ultimate tensile strength of composite with reinforced untreated PALF, alkaline treated PALF, and Bleached PALF. Tensiletest was observed at Laboratory Clinical Pharmacy, Airlangga University, Surabaya.

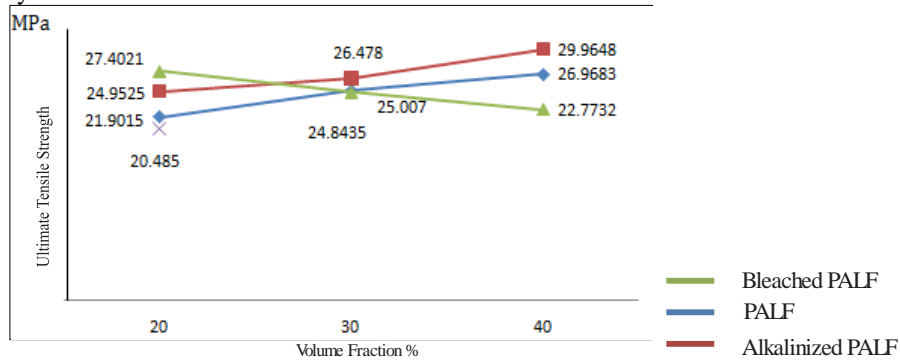


FIGURE 4. Ultimate Tensile Strength of composite

In Figure 4, there had an increasing value of ultimate tensile strength for composite with untreated PALF, and alkaline treated PALF following addition of volume fraction of fiber. However, there is degradation of ultimate tensile strength of bleached treated PALF following addition of volume fraction of fiber. All value ultimate tensile strength of composite reinforced PALF were higher than neat poliester, and the value of alkaline treated PALF were

higher than untreated PALF. And bleached treated PALF value were higher than alkaline treated PALF and untreated PALF at 20% volume fraction.

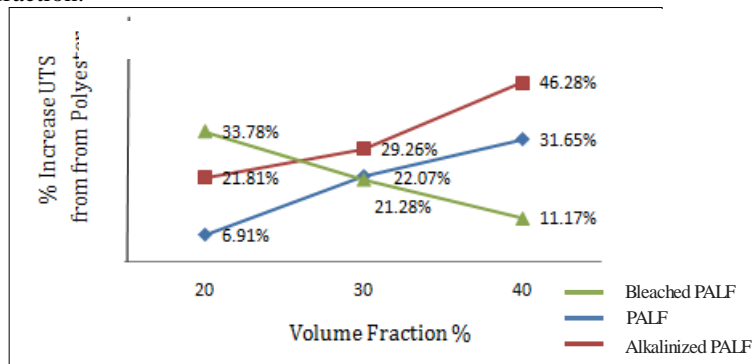
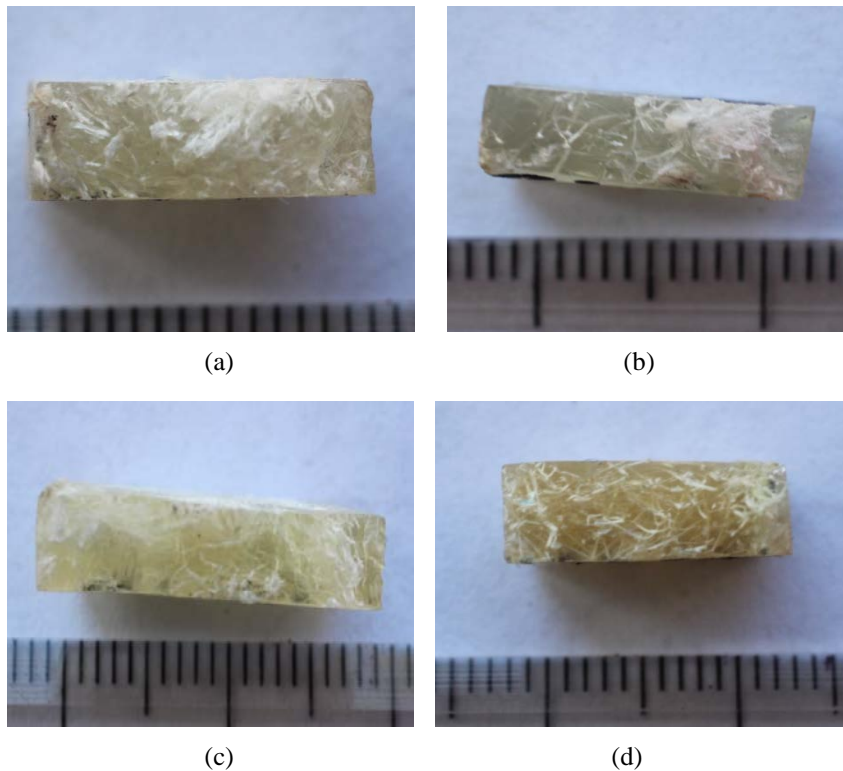


FIGURE 5. Percentage of increasing Ultimate Tensile Strength

So, PALF treatment had some effect for mechanical properties of composite reinforced PALF, different treatment had different effect of mechanical properties. The best treatment determined Figure 5 were bleaching treatment for volume fraction 20%. However, the optimum value were alkaline treated PALF with volume fraction 40%. The chemical treatment verified that can improve mechanical properties, degradation of hemicellulose and lignin had improve the content of cellulose, and respectively, mechanical properties of composite were increase. Degradation of wax layer and hemicellulose were these component hidrophobic able to improve wettability and bonding between fiber and matrix better, so mechanical properties were increase.

Dispersion and Distribution Effects

Dispersion and distribution of fiber at composite were very important, because that can influence mechanical properties of composite. If distribution and dispersion were good, mechanical properties would improve.



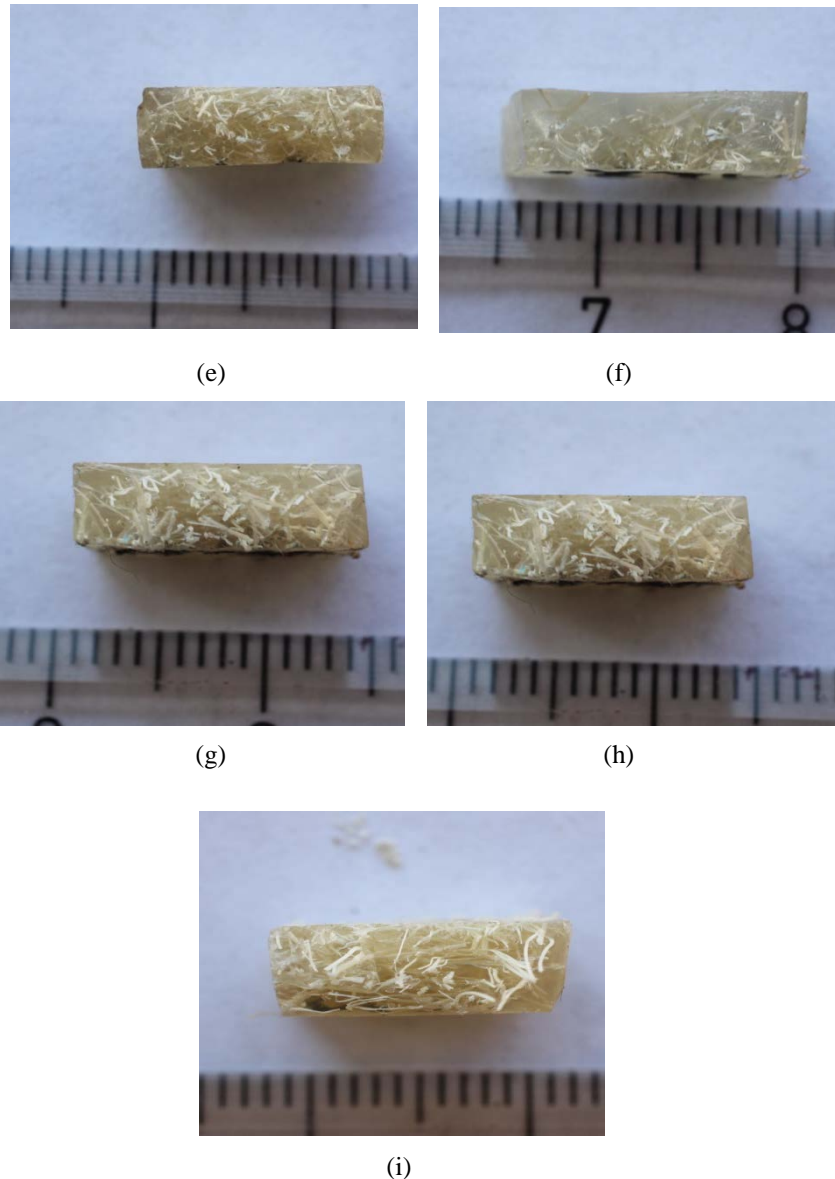


FIGURE 6. Fractured surface a) bleached PALF 40% ; b) bleached PALF 30% ;c) bleached PALF 20% ; d) Alkalized PALF 40% ; e) Alkalized PALF30% ; f) Alkalized PALF 20% ; g) PALF 40% ; h) PALF 30% ; i) PALF 20%

In Figure 6. observed there were photo of fracture surface after tensile test, in Figure 6.a and b, its clearly that distribution and dispersion of fiber were not good, an agglomeration found in bleached PALF 40% and 30% composite, that indicated poor distribution and dispersion. So, mechanical properties decreased, it shown in figure 4, ultimate tensile strength of 30% and 40% bleached PALF composite respectively decreased. Panyasart et.al investigated distribution and dispersion of composite would decreased mechanical properties, because the matrix can't cover all of fiber, so distribution of stress when sample received loading weren't good enough, and mechanical properties were slightly decreased.

Morphology of Composite

In Figure. 7 it shown morphology observed under optical microscope, Figure 7.a and b, its clearly shown that fiber pull out were obtained in composite bleached PALF 30% and 40%, that's indicated compatibility of fiber of composite weren't good, matrix couldn't binding fiber perfectly. So, mechanical properties has more lower than other. Manalo et.al investigated ^[14] fiber pull out indicated low wettability of fiber, so binding between matrix and fiber weren't going well, and caused matrix broke before fiber received a load.

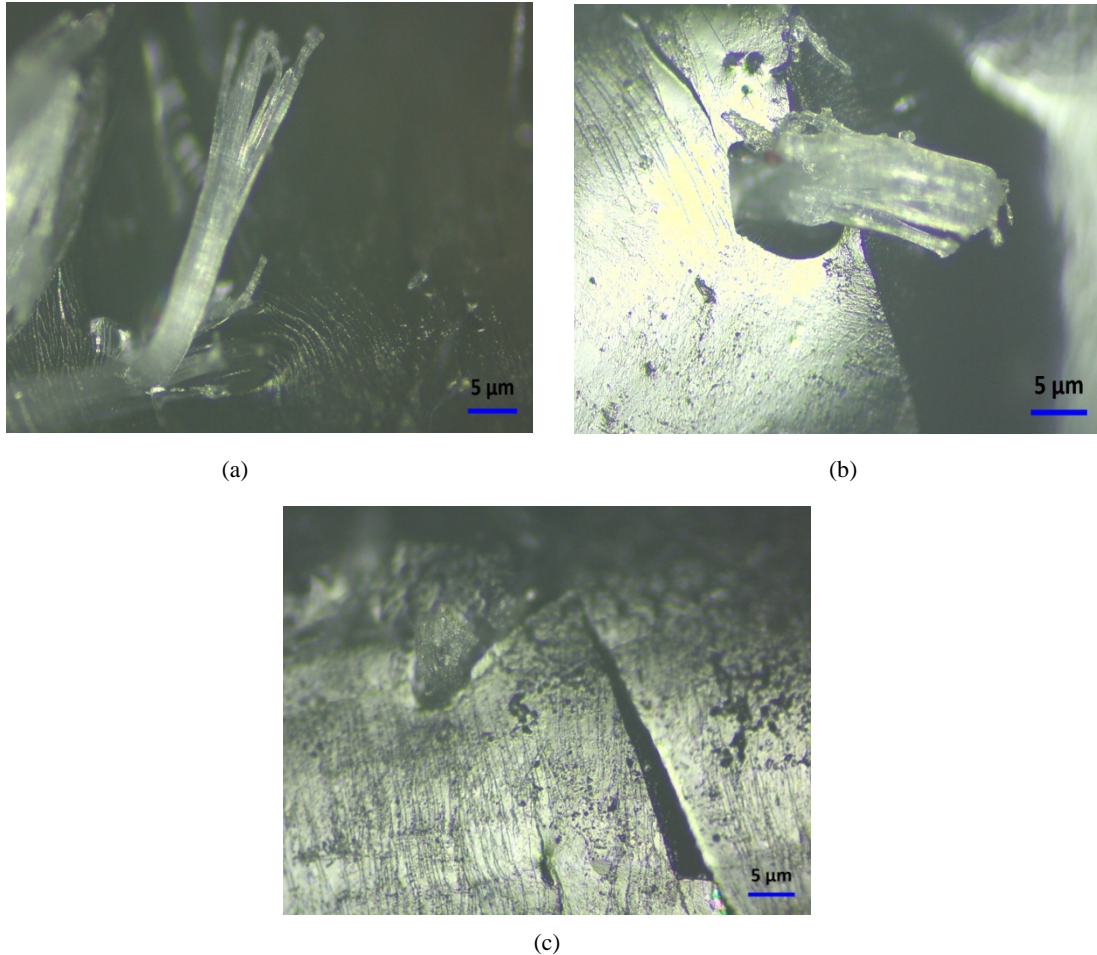


FIGURE 7. Morphology of fractured surface composite; a) Bleached PALF 40%; Bleached PALF 30%; c) Bleached PALF 20%

CONCLUSION

Ultimate Tensile Strength value increased following increasing volume fraction of fiber, except Bleaced PALF, the optimum value of Ultimate Tensile Strength is 29.9648 MPa for 40% Alkalinized PALF composite. Dispersion and Distribution was discovered, there is an agglomeration at composite bleached PALF 30% and 40%, so Ultimate Tensile Strength decreased at 30% and 40% Bleached PALF. Morphology of composite was discovered and found fiber pull out at bleached PALF composite 30% and 40%

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