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ANALYSIS TO DETERMINE THE SUITABLE COATING MATERIALS FOR ENVIRONMENTAL FRIENDLY COMPOSITES FROM OIL PALM EMPTY BUNCH FIBERS

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ABSTRACT

The growing demand of crude palm oil (CPO) in local and world markets led to the increasing palm oil production and the expansion of oil palm plantations in Indonesia. Together with the increasing CPO production the wastes generated at palm oil industry are igrowing as well. One of the solid waste (biomass) at the palm oil mill is empty fruit bunches of oil palm (EFB). The utilization of EFB for environmental friendly composites (bio composites) can reduce the amount of this biomass which so far has less uses for technical sectors. The good properties of natural fibers of EFB for technical applications are such as high mechanical strength, good heat resistance and as lightweight material, good resistance electrical conductivity. However, bio composite has the disadvantage since this material is not water proof, neither humidity resistant. So that for its implementation as technical products the suitable coating material is necessary. This paper focuses on the production of bio composites, its bending test and its water resistance test in kind of soaking test. The coating materials used for this research were laminate sheet (plastic), bee wax, carnauba wax and craft glue (synthetic). The test results indicate that the coating using laminate sheet showed suitable results than the other of coating materials: bee wax, carnauba wax, craft glue.

Key words: *composite, coating, empty fruit bunch of oil palm*

1. INTRODUCTION

Oil palm cultivation and plantation expansion in Indonesia continues in growing trend from year to year. Its reason is the crude palm oil (CPO) has great economical meaning. CPO is obtained in oil palm fruits. This vegetable oil is the important commodity for Indonesian's export. Its growing demand in local as well as world markets accelerates the CPO production in Indonesia. Indonesia expands the areas of oil palm plantation to gain more CPO production. Together with the growing CPO production the wastes at palm oil mill and at plantation are increasing as well. In last 7 years the plantation expasion increases of about 1.40 up to 9.05 % per year (Biro Pusat Statistik, 2013).

The wastes generated are in kind of solid, liquid and gas. Empty fruit bunch of oil palm (EFB) is one of solid wastes which is generated at the palm oil mill. This biomass has the potential to be used as raw material in the form of natural fibers for industries. These fibers can be used as main stuff of environmental friendly composite (bio composite). Bio composite can be implemented furthermore as bulletproof material, exterior and interior materials of a vehicle, sound proofing and temperature insulating materials and other purposes. Bio composites as filler can used as a substitution of synthetic or mineral stuffs which are not environmentally friendly and not renewable.

The EFB fibers have an advantage in comparasion to non organic materials such as ceramic and aramid. Inorganic materials are made through some complex and long processes and there are additional materials are needed such as non metallic stuffs to

achieve the desired strength. While the composites from natural fibers can be produced through a simple manufacturing process, the product is environmentally friendly, renewable and needs less production cost. It is biodegradable because for the production will be used adhesive based on potato. This composite has good properties for technical purposes such as high mechanical strength by about 8 GPa, good heat resistance at 240 ° C and good durability of electrical conductivity (A. C. Arya, 2005).

It is expected that the composites produced have a mechanical strength that can equal or equivalent to the mechanical strength of ceramics but these are also not easily broken. Nevertheless these bio composites are not water proof and humidity resistant. So that modification to improve its property against water and air humidity is necessary. The lack of resistance to water and humidity will cause strength reduction. The coating process becomes a important process for the bio composites.

The purpose of this study is to determine the types of coating materials which can improve the property of bio composites so that they will be humidity and waterproof, posssible with less weight addition and high mechanical porperty. To achieve this objective 4 types of coating materials tested: laminate sheet (plastic), bee wax, Carnauba wax and craft glue.

2. THEORETICAL BACKGROUND

The composite is a kind of material which consists of two or more materials with different properties chemical or physical. Its combination produces different properties than the main materials. From 2 or more materials will be formed a single component. These 2 or more components are generally matrix and reinforcement. The matrix is a composite part that gradually surround has a function as binder. While the amplifier is the component which will be added to the matrix. It serves as the main load-bearing receiver by the composite (like bones). There are 3 types of composites load receiver: fiber composite material, the composite layer, the composite particles.

The environmental friendly composite (bio composite) is a combination of natural fibers such as wood fiber or fiber of wheat, kenaf, hemp, jute, sisal and flax with a polymer matrix. The applications of biocomposites are already widely known especially in medical or healthcare field. Biological based materials become an important issue also in the building industry, construction and others. The use of natural fibers in a variety of applications must show the good mechanical strength. Natural composite made from oil palm empty fruit bunches with binding agent from potato will be produced after hot pressing with aims to achieve the shape and the desired mechanical strength.

Binding or joining two or more materials are possible through adhesion. Adhesion is defined as a state or condition in which the binding of two surfaces to be unified as one body because of the binding forces between its surfaces. These forces are known as bonding force can be valence ionic binding or interlocking forces (Prayitno, 1996). According to Brown et al., (1952) gluing is a system consisting of different materials which are associated together to form one body influenced by the adhesive and the adhesive surface conditions.

Natural adhesive is usually made from minerals or organic (biological resources) such as vegetables, starches, natural resins and its mixture of mineral and biological resources. While synthetic adhesives are generally made of elastomeric and thermoplastic made by humans through the mixing of chemicals (synthetic).

Coating is a process to protect the material from corrosion and provide protection to that material will be isolated from the outside system. In addition, the coatings also provide negative buoyancy, provide anti slip function on the surface and some other functions. (Holmberg , K. and Matthews , A. 2010) .Matthews, A. 2010).

Resilience coating is strongly influenced by the ability of the coating to stick on the material. If the adhesive is not strong enough to coat, so that it will not stick well. That is why coating can also provide to isolate the materials from air humidity.

3. MATERIALS AND METHODS

EFB as raw material was obtained from palm oil mill plantation PTPN VIII Kertajaya, Banten, West Java. The raw material is provided from a palm oil mill as waste. This waste is generated after separation process between the bunch and the fruit in thresher machine. The EFB will be collected and picked from the disposal storage up at the palm oil mill. The EFB will be furthermore fiberized and screened, the only golden yellow fibers will be chosen. It is a good fiber which will not break if it will be pulled and pushed. The next stage is the process of making glue (binding agent/adhesive) from potatos. After gaining the potato extract as powder it will be mixed with water and heated by temperature of 60 °C. The mixture of fibers and additive 1 to 0.75.

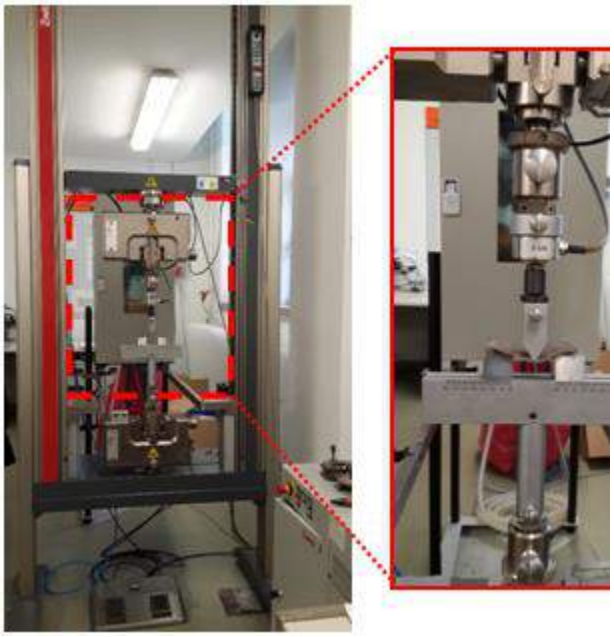

Figure 1 The 3 Points Bending test by Using ZWICK Machine

The fibers and binding agent will be mixed, compressed and formed to be prepregs. Prepregs will be hot pressed by temperature of 180 ºC for about 15 minutes. The result is a bio composite plate. The plates produced will be stored at room temperature by 26 ºC . Edge cutting is the next process before the coating process. The composites will be finally coated by using several types of coating materials such as bee wax, carnauba wax, craft glue and laminate sheet (plastic). 3 points bending test and soak test are done to determine which coating material has highest mechanical strength. 3 points binding test was run by using a Zwick machine (see Figure 1).

The aim of soaking test is to determine which type of coating materials can isolate the composite properly against water. The indicator is less weight addition. Figure 2 shows the flowchart of composite production by utilizing the EFB fibers.

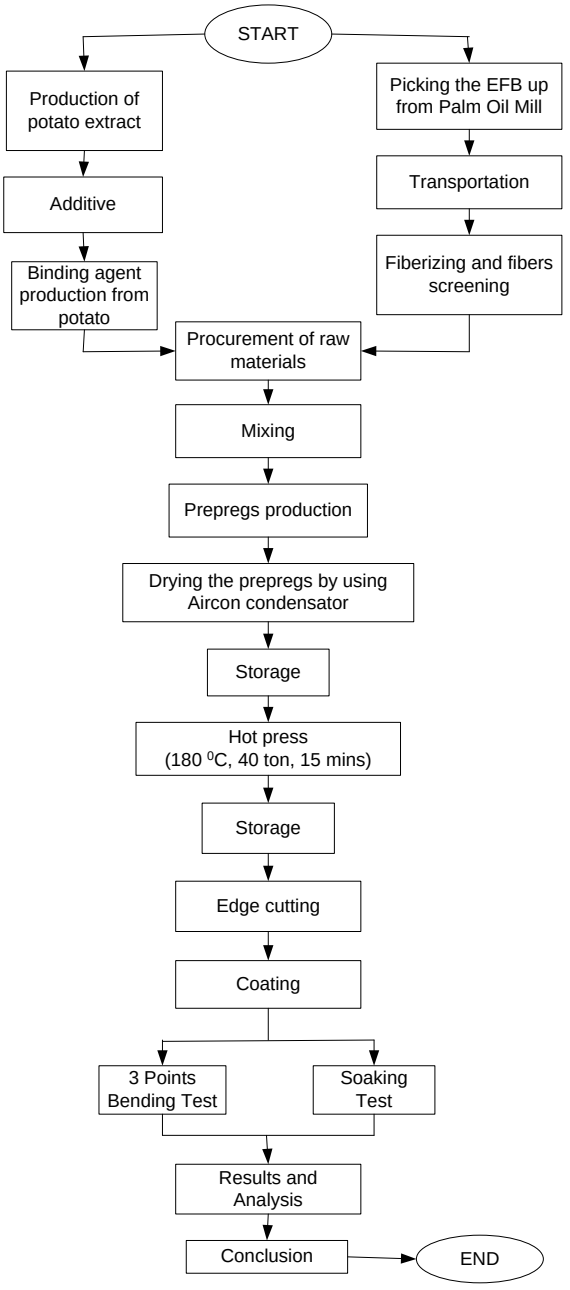

Figure 2 Flow chart of making bio-composite products

4. RESULT AND DISCUSSION

The fiberizing of EFB is the first process run at this research to gain the appropiate fibers for the composite production. The fibers are mixed with the binding agent based on potato. The mixture stuff between EFB fibers and binding agent will pressed and formed to be prepregs.
After mixing process the next stage is the compression or pressed the mixture to be prepregs.Finally, the prepregs will be hot pressed to produce bio composite. The composites will be cutting at its sides (edge cutting). After that the composites will be coated. In this study, the experimental coating materials are laminate sheet (plastic), bee wax, carnauba wax and craft glue.

Table 1 Results of 3 point bending test of 4 coating materials (N)

No.	Laminate	Bee wax	Carnauba wax	Craft glue
1	635,5	984,7	469,7	229,5
2	752,9	529,6	488,1	260,0
3	607,9	631,7	303,6	330,8
4	711,4	373,6	386,6	506,1
5	664,1	658,4	265,6	340,9
6	806,8	788,5	464,5	692,2
7	814,3	384,2	248,1	534,4
8	662,2	947,8	756,9	488,1
9	749,3	511,3	729,3	445,0
10	647,4	911,9	458,0	664,3
11	639,0	1187,3	609,3	660,5
12	666,3	773,0	645,4	510,6
13	607,0	773,8	615,3	918,8
14	712,2	713,7	983,5	586,4
15	752,0	622,4	440,3	388,7
16	807,3	895,8	749,7	463,6
17	646,0	903,8	654,1	634,7
18	662,9	311,7	515,0	625,0
19	816,6	1113,3	383,9	598,2
20	748,9	777,7	634,9	409,3
Rata2	**705,5**	**739,7**	**540,1**	**514,4**

The next phase is the tests stages of the bio composites which have been coated. There were 2 kind of tests, firstly the 3 points bending test to determine the mechanical strength, secondly soak testing to determine resistance to water absorption.
The 3 Points Bending Test was run by using Zwick Machine. Number of samples are 20 bio composites. Bending test is run by placing the bio composites under force (Newton). With helping of TestXpert software the results of maximal force will be noted. Table 1 shows the result of bending test.
Testing average buckling strength between multiple coating is calculated by using One Way Analysis of Variance at a significance level (level of significance) of 0.05 . The zero hypothesis is number of the difference of mean bending strength (N) all samples: laminate, bee wax, Carnauba wax and craft glue.

$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu_4$
H1 : at least two average (mean) is not the same
$\alpha = 0{,}05$
Reject H_0 if $P_{value} \leq \alpha$

Test using Minitab 16 Statistical Software is as followed

```
Source  DF       SS      MS     F      P
Factor   3   781847  260616  8,31  0,000
Error   76  2383449   31361
Total   79  3165297

S = 177,1   R-Sq = 24,70%   R-Sq(adj) =
21,73%
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The results show that the value of $P_{value} = 0$ so that at the 0.05 level of significance the null hypothesis will be rejected. From the test results it has conclusion that there are differences between the mean Bending tests between multiple coatings in the experiment. In the test results shows that the samples coated by bee wax have the highest average bending force followed by laminate, carnauba wax and craft glue.
The next test was the soak test which is to determine the property of bio composites against water. Soak test for bio composite which have been coated aims to see at least the type of coating that less absorbs water. The testing process is done based on the time and final weight of the samples. The bio composite would be put in water. It showed the properties of the all samples against

water. Soaking duration would be measured were after 1, 3 and 5 hours. Before soaking test the bio composite will be measured their weights then after each soaking duration. The final weight or its weight difference will be recorded.
Soak test results after immersion for 5 hours and recording weight gain (%) of the bio composites for each type of coating is shown in Table 2 .

Tabel 2. Soak test results are 4 types of coating materials

Sample No.	Weight gain (%)			
	Laminate	Bee Wax	Carnauba Wax	Craft Glue
1	2.25	113.41	206.85	259.52
2	3.13	320.00	181.33	246.25
3	5.81	108.86	191.78	212.50

Soaking test results indicated that there is a minimal absorption by coating material of laminate. A it is seen from the percentage weight gained where there is most less weight addition in comparation to the other types of coating materials.
Although the results of bending test of laminate is slightly smaller than bee wax but the soaking test showed different result where its percentage of weight addition was quite large than bee wax. This suggests that the laminate still show advantages as coating material than the other three coating materials.
The limitations of this study is the amount of samples at soaking test, since it was not adequate due to the limitations of the available raw materials. Statistical test can be done if the sample number and the sample size is representative.

5. CONCLUSION

From the results of bio composite coated by using several types of materials it gave conclusion that the 3 points bending test showed that the coated composites by using bee wax has the greatest bending strength, followed by laminate, carnabau wax and craft glue. After running soak test the results showed that the laminate is the best type of coating material in comparasion to the three other types of coating materials. From these kind of two tests it can give conclusion that the type of laminate is the suitable coating material to be used for the bio composite from EFB fibers.

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