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A study on biocomposite from local balinese areca catechu l. husk fibers as reinforced material

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Abstract. Untapped areca catechu l. husk fibers optimally can cause pollution to the environment. Therefore it is necessary to learn the characteristics of local balinese areca catechu l. husk fibers, such as physical, chemical, morphological, and mechanical. AHF testing the tensile strength with a single pull fiber test in accordance with ASTM D 3379 in the amount of 146-152 MPa. While the observation of the physical properties, of local balinese areca catechu l. husk fibers have a diameter and length variations of each 250-540 µm and 9.24 to 55.20 mm, with an aspect ratio of between 31.43 to 102.22, density ranges between 0:48 - 0.74 kg / cm^3, absorption lower water (90-150%) when compared to AHF grows in other areas. From this study it appears that local Bali AHF can be used as reinforcement in composite replacement for synthetic fibers.

1. Introduction

Areca fibers can be used as a composite reinforcement [1], which contains lignocellulosic plant tissue structures that are environment friendly and biodegradable [2], support ĸarbondiokasida cycle in the atmosphere [3]. Applications areca as reinforcement fibers biocomposites has not been widely used. Natural fibers have been used are kenaf, sisal, hemp, jute and others [4] in the automotive, packaging [5], construction, interior and furniture [6]. Aplication of natural fibers as reinforcement composites have several advantages: lower density, renewable source, low cost and low investment, reduce wear gear, healthy working conditions, good acoustic and thermal insulation [7]. But natural fibers have some disadvantages low wetability, incompatibility with some hydrophobic polymer matrix, a low melting point and high water absorption [2]. However, this weakness can be overcome with some chemical treatment [8]. Areca trees bear fruit depends on soil conditions [9], the average in bali areca trees bear fruit after 5-8 years old, elliptic fruit shape between 3.5 - 7 cm. Stringy fibrous fruit wall hard covers endosperm [10] ,husk weight approximately 60-80% of the total weight. Fibers length 3.5 - 6 cm, diameter 0.3 mm-0.5 mm. In general, the chemical composition of areca fibers composed of cellulose (hemicellulose), lignin, pectin and protopectin [11]. Areca tree plantations developed on a large scale to take its seeds as raw material for cosmetics, healthcare, and industrial paints [12, 13]. AHF are finding use in fabrication of value added products such as cushion, hard boards, non-woven fabrics and housing insulation materials [14]. Areca based on the level of maturity there are three types of raw areca nut, ripe and dried [14], so that the waste from the skin also there are 3 types of leather waste of raw areca nut, ripe and dried. Raw areca green, soft leather and hard-shelled seeds, areca ripe golden yellow and the skin is chewy to contain a lot of liquid when compared to the raw and dried fruit. The dried areca obtained when it reaches full maturity and apart from fruit bunches. Dried areca show a brownish color with coarse fibers. Fibrous part of areca there are two types of fibers is thin and coarse fibers. Crude fibers surface roughness of AHF can be taken into consideration in choosing a good fibers as reinforcement in composites. This study investigates the physical, chemical, morphological, mechanical and thermal characteristics of areca leather fibers (Areca Husk Fibers / AHF). AHF is extracted from the fibrous bark near the shell of the fruit.

Some studies related to the development of AHF as a composite reinforcement has been done such as short fibers characterization of areca [10], AHF research on the tensile strength of polypropylene composites [2], studies of bending strength and impact AHF [15], AHF performance in epoxy composite [16] and others. Although it has been studied about the AHF for use as reinforcement in composite materials, AHF research has not found that the agricultural commodities local Bali. Several different fundamental between local balinese areca with others is elliptic shape and fruit size is smaller when compared with other areca, in addition to the soil and climate conditions will also affect the characteristics of plants including fruit and fibers skin [17].

2. Research Methodology

AHF obtained from local areca plantations in Bongaya village, Karangasem, Bali. Areca immersed in water at room temperature for 5 days to loosen the fibers from the husk. Furthermore, AHF is separated manually from the shell by hand. After stripping is washed with distilled water before being dried in an oven at 70 ° C for 24 hours. AHF has done is stored in an enclosed space to protect the fibers from atmospheric moisture. Fifteen samples of AHF is measured and the average fibers diameter and length was recorded. Density AHF obtained using a mathematical equation that is dividing the mass by volume.Water absorption is determined after soaking the samples in water at room temperature for 24 hours. Study on morphology of the AHF surface and cross section using a scanning electron microscopy (SEM). AHF chemical composition testing such as cellulose, hemicellulose, lignin and wax were determined using standard test procedures [18]. AHF for tensile test specimens were randomly selected from fibers of the skin. Fibers were observed using an optical microscope to measure the diameter of the fibers. Fibers affixed to a piece of cardboard, with a gauge length of 25 mm and tested according to standard test method for single fiber tensile test (ASTM D 3379-75). Cardboard cut in the mid-section before measuring the tensile test [9]. Specimens were tested with a crosshead speed of 1 mm / min with the replication of 15 specimens, with a load capacity of 5 kN.

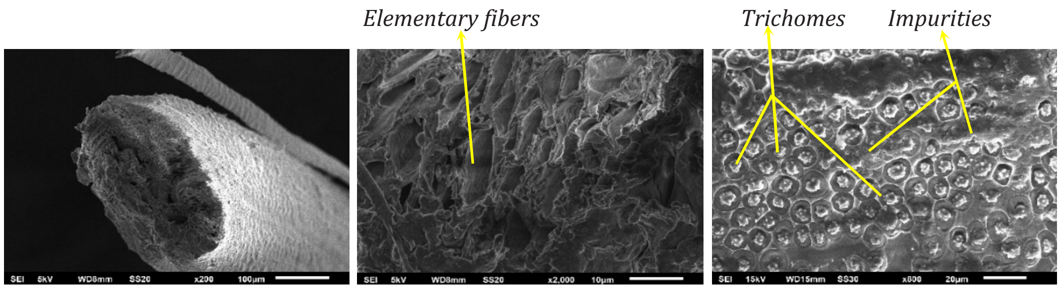
3. Results and discussion

Physical properties of AHF

AHF there are 2 types of coarse fibers and fine fibers, so that the fibers diameter varies from 250-540 μm as well as fibers length 11.24 - 55.20 mm more varied dimensions when compared AHF investigated by Binoj and Yusriah. Fibers length and diameter of the fibers is an important parameter for determining the strength of natural fibers [19]. By dividing the length of the fibers diameter, the aspect ratio of natural fibers can be calculated, asek ratio AHF 31.43 - 102.22. Natural Fibers with a high aspect ratio is more favorable because it has a high tensile strength [4]. In addition, the aspect ratio of the fibers have a significant effect on the flexible nature and behavior of natural fibers rupture [20]. Local balinese areca fibers density ranges between 0:48 - 0.74 kg / cm3. water-absorption of fibers is the fiber's ability to absorb water vapor in a given time. This greatly affects the properties of the composite characteristics that use natural fibers as reinforcement, particularly in the use of composites in the outdoors and life time composites. Water absorption can decrease the bond interface between the fibers with the polymer so that it will affect the mechanical properties. Water absorption of local balinese AHF range 90-150%, lower than AHF investigated by Yusriah and Hasan. Moisture content is one of important parameters that should be Considered in Choosing natural fibers as reinforcement in polymer composites. Moisture content of natural fibers determines the dimensional stability, electrical resistivity, tensile strength, porosity and swelling behavior of natural fibers reinforced composites [21]. Composites reinforced with high moisture content of fibers are often prone to decay as compared to the composites reinforced with low moisture content fibers [40]. This is likely due to the ability of the fibers to hold up water molecules within the composites, which act as degradation agent in the composites. SEM of AHF figure 2. The size of lumen in natural fibers is proportional to the diameter of their respective fibers, where the lumen size increases with the increase in fibers diameter [22]. cross section of a fibers showing the arrangement of individual cells. The bundle is slightly flattened from being cut.

Table 1. Physical properties AHF

Materials	Diameter (μm)	Length (mm)	Aspec ratio	Density (gr/cm^3)	Water absorption (%)	Moisture (%)	Color fibers
Local balinese AHF	578 ± 9	36.2 ± 12.6	63.3 ± 22.9	0.63 ± 0.13	120.7 ± 30.0	10.4 ± 0.2	Golden brown
AHF [9]	396 - 476	10 - 60	-	0.7 – 0.8	-	7.32	-
AHF [14, 23]	401 – 470	49 – 57	-	0.19 – 0.38	116 - 231	3.7 - 60	-



(a) (b) (c)

Figure 1. (a) SEM of AHF (b) cross section of AHF (c) surface of AHF

The chemical composition of the fiber can be different from the same species. The chemical composition of the fiber affects the mechanical strength, moisture, morphology and characteristics of the bond, so it will take effect when the fiber is used as a reinforcement in composite [9]. local balinese AHF chemical composition when compared with other regions, local balinese AHF sellulose content of 52.34 - 55.89%. Lower hemicellulose content is desirable, Because content will degrade its higher thermal stability and increases the moisture absorption capacity [24]. Lignin improves the rigidity and stiffness of the fiber by bonding together the cell wall structures. It also helps in bonding with polymers when used as a reinforcement in polymer matrix composites [25]. lignin is the main element of areca, which gives rigidity to the AHF. Lignin is also responsible for the color change of the fiber [4].

Table 2. Chemical properties AHF

Materials	Cellulose (%)	Hemicellulose (%)	Lignin (%)	Ash (%)	Wax(%)	Other
Local balinese AHF	54.15 ± 1.78	16.61 ± 1.58	21.02 ± 1.36	2.02 ± 0.42	0.77 ± 0.21	4.44 ± 1.49
AHF [9]	57.35 – 58.21	13 – 15.42	23.17 – 24.16	-	0.12	-
AHF [23]	53.20	32.98	7.20	1.05	0.64	3.12

Table 2 shows the tensile strength, Young's modulus, and elongation at break of AHF study ever conducted. There are many factors affecting the tensile properties of natural fibers such as species and varieties of plants, the level of maturity of plants, soil and weathering conditions and also the efficiency of the retting process [22]. Tensile strength of local Balinese AHF quite high when compared with other regions and the lowest elengationnya 4.9 - 10.9%.

Table 3. Tensile strength and young's modulus AHF

Mechanical Properties	Local balinese AHF	AHF [9]	AHF [14, 19]
Tensile strength (MPa)	148.32 ± 2.84	147 – 322	123.93 – 166.03
Break elongation (%)	7.15 ± 3.29	10.23 – 13.15	22.56 – 23.76
Young's modulus (GPa)	2.33 ± 0.83	1.12 – 3.16	1.26 – 2.57

Conclusion

The results of this study shows that the local balinese AHF can be used as a reinforcement in composite replacement for synthetic fibers. With varying aspect ratio and a lower water absorption thus allowing used according to the application and either used outdoors as well as a longer shelf life. In addition local balinese AHF has a lignin content is high enough so that the strength of the fiber and composite will increase.

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