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Mechanical Properties and Water Absorption of Coir and Angustifolia Haw Agave Fibers Reinforced Hybrid Polyester Composite

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ABSTRACT

This article presents the mechanical properties (including tensile and flexural stength) and water absorption of coir/ angustifolia Haw Agave fibers hybrid composite. Prior to fabrication of composite, these fibers were soaked in 5%w/v NaOH solution during 24 hours. Coir fibers were manually twisted and formed like mat and agave fibers were composed with one direction and then also formed mat. Unsaturated polyester was used as matrix in hybrid composite. Fabrication of hybrid composites used hand lay-up technique with compression molding. The variation of volume fraction of coir and agave fibers in hybrid composite are 5:25, 10:20 and 15:15 respectively. Tensile and flexural strength as well as water absorption of hybrid composite were investigated in this paper. Fracture tensile was examined by Scanning Electronic Microscopy (SEM) to determine fracture mode. Results showed that by combination of coir and agave fibers as reinforcement of hybrid composite, higher content of agave fiber in the hybrid composite is higher tensile and flexural strength. Meanwhile, the higher content of agave in hybrid composite, the water absorption also increased. SEM examination shows that the hybrid composite tend to undergo fiber pull out and matrix defect.

Keywords: Coir fiber, angustifolia Haw agave fiber, polyester, water absorption, hybrid composite.

1. INTRODUCTION

Natural fiber composites have gained attention in the last decades due to their advantages. The advantages of these are no expensive, biodegradable, abundant, lightweight, higher toughness and renewable [1]. Some natural fibers have been used as reinforcement of composite like ramie, jute, coir and sisal. In this paper, coir and angustifolia Haw Agave fibers were hybridized as reinforcement of composite. Mechanical properties of coir fiber have been studied by researchers [2], [3] and agave fiber by Silva-Santos et al [4].

A combination of natural fibers as reinforcement of composite has been investigated. Srinivasan et al [5] reported that strength of hybrid composites is better than the single fiber composite. Hybridization of coir and palm fibers as reinforcement of HDPE matrix has intermediate value of mechanical properties for each fiber with non-hybrid composite of coir fiber and palm fiber [6]. According to Islam et al. [7], incorporation of kenaf and coir fibers as

reinforcement and montmorillonite combined can increase mechanical properties and improve water absorption of hybrid composite. Akash et al. [8] studied mechanical properties of sisal/coir fiber hybrid epoxy composite where tensile and flexural strengths of 40%wt coir and sisal fiber have higher than other fiber content. Bakri et al. [9] evaluated strength of coir/agave fibers hybrid composite using epoxy resin as matrix where composition of coir and agave fiber (15%Vf and 15% Vf) has better tensile and flexural strength as compared to other compositions. Deflection of coir/agave fibre hybrid composite with polyester matrix was studied by Naharuddin et al. [10].

In this paper, hybridization of coir fiber and agave fiber as reinforcement in composite was performed. Tensile, flexural and water absorption of hybrid composite were evaluated. Tensile fracture was examined by Scanning Electron Microscopy (SEM).

2. EXPERIMENTAL METHOD

Coir fibers were extracted from husk of coconut and Agave angustifolia Haw fibers were extracted from agave leaves. These fibers were soaked in 5%w/v NaOH solution during 24 hours, then, rinsed with fresh water and followed by drying at room temperature during 2 days and oven drying for 2 hours at 100°C. Coir fibers were manually twisted and formed as coir mat and agave fibers were composed with one direction and then formed mat. Unsaturated polyester was used as matrix and purchased from local market.

Hybrid composite of twisted coir fiber and agave fiber mat was molded with hand layup process using a steel plate mold followed by compression molding. It is fabricated with 30% fraction volume of fibers. The position of twisted coir fiber mat is as a skin and agave fiber mat is as a core. Composition of hybrid composite can be seen in Table 1. Hybrid composite of coir fiber mat and agave fiber mat is molded with hand layup process using a steel plate mold.

Table 1. Volume Fraction of hybrid composite

Symbol	V_f (%)		V_m (%)
	Coir	Agave	Polyester
5C25A	5	25	70
10C20A	10	20	70
15C15A	15	15	70

A: Agave, C: Coir

3. RESULTS AND DISCUSSION

The tensile strength of coir-agave fiber reinforced hybrid composite with different of volume fraction of fiber is shown in Fig.1 where value of tensile strength of hybrid composite decrease with increasing content of coir in the composite or inversely decreasing content of agave in the composite is rising tensile strength of composite. When volume fraction of agave fiber is 20% of 30% Vf in the composite, hybrid composite tensile strength decreases about 12% from volume fraction of agave fiber 25% Vf in composite and deacresing about 30% when volume

fraction of agave fiber is 15% in the composite.

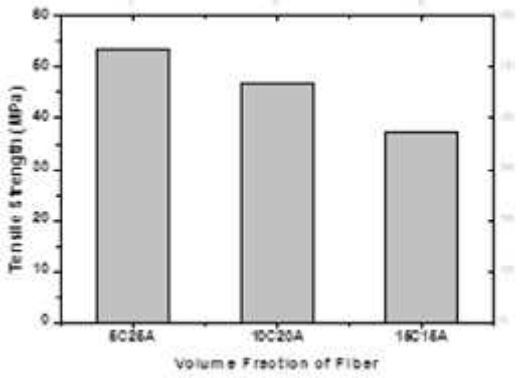

Fig. 1 Tensile strength of agave and coir fibers hybrid composite

Meanwhile, tensile modulus of hybrid composite as shown in Fig.2 is also decreasing with decreasing of agave fiber content in the composite. This may be caused by modulus of agave fiber [4] is higher than coir fiber [3] so that decreasing of agave fiber content in composite can decrease modulus of hybrid composite. Value of this tensile modulus has been published by author before [10].

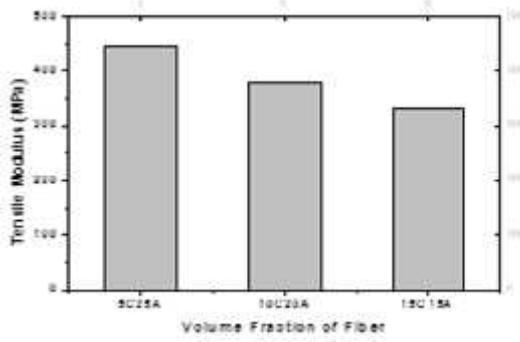

Fig. 2 Tensile modulus of agave and coir fibers hybrid composite [10]

The flexural strength and flexural modulus of coir-agave fiber reinforced hybrid composite related to volume fraction of coir and agave fiber can be seen in Fig. 3 and Fig.4.

The flexural strength and flexural modulus of hybrid composite are different with difference of volume fraction. Agave fiber content of 25% in the composite has higher flexural strength and flexural modulus than others. The higher content of agave fiber in the hybrid composite is higher flexural strength and flexural modulus. This is because of stiffness of agave fiber is higher than coir fiber.

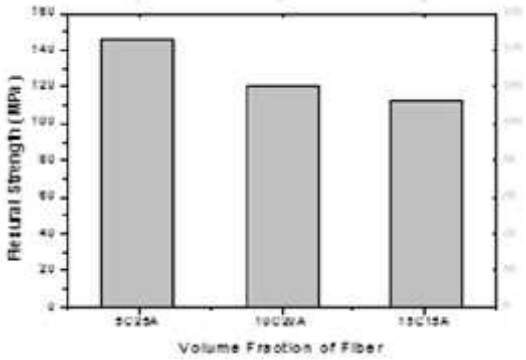

Fig. 3 Flexural strength of agave and coir fibers hybrid composite

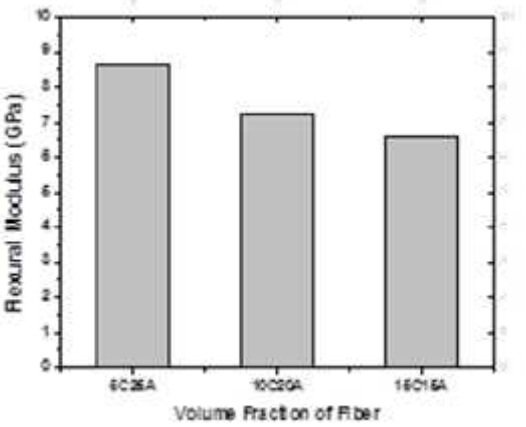

Fig. 4 Flexural modulus of agave and coir fibers hybrid composite

Tensile fracture surface morphology of hybrid composite was examined by scanning electron microscopy (SEM). SEM

micrographs of hybrid composite can be seen in Fig.5 (a), Fig.5 (b) and Fig.5 (c).

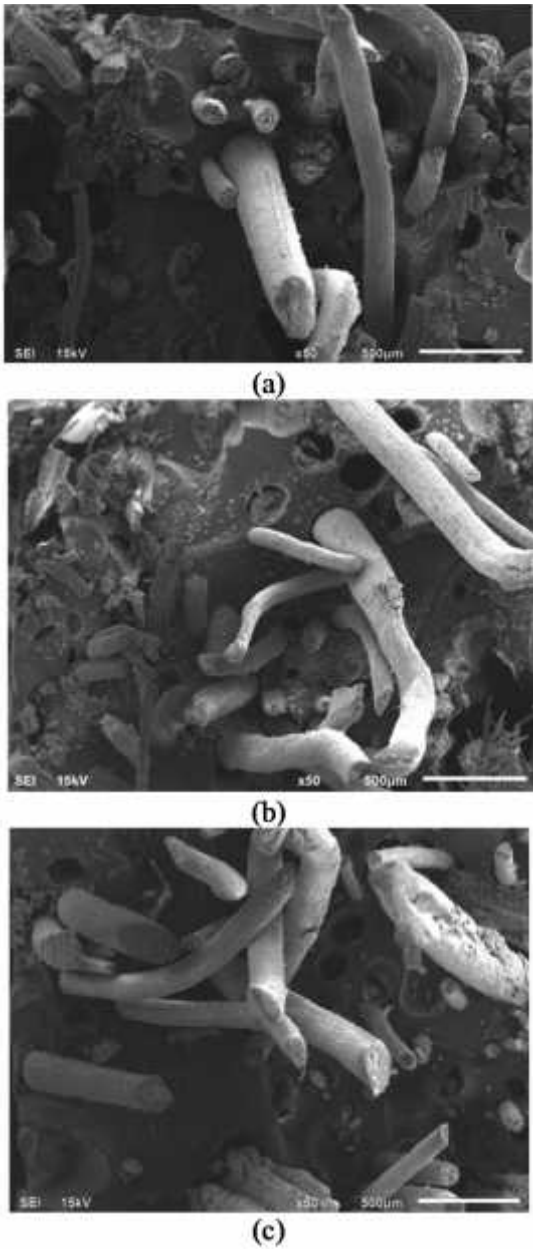

Fig. 5 SEM image of agave and coir fibers hybrid composite tensile fracture (a) 5C25A, (b) 10C20A and (c) 15C15A

All SEM images show pull out, fracture of fiber and matrix defect occur after tensile load of composite. Fibers were pulled out in this composite due to insufficient interface bonding between fiber and matrix. According to Haris et al.[11], fiber pull-out cause void on the matrix indicating a low interfacial adhesion between fiber and matrix.

Water absorption of the hybrid composite as immersion time function can be seen in Fig. 6. It shows that hybrid composite at the first stage absorps water rapidly and then tends to constant after 72 hours immersion where the equilibrium moisture content at saturation level attained. The higher percentage of water absorption is a sample of volume fraction coir and agave 15:15 of hybrid polyester composite as compared to 5:25 and 10:20. The higher moisture absorption of hybrid composite is because of hydropilic properties of natural fiber. According to Islam et al. [7], the single fiber composite has lower water absorption than the hybrid composite.

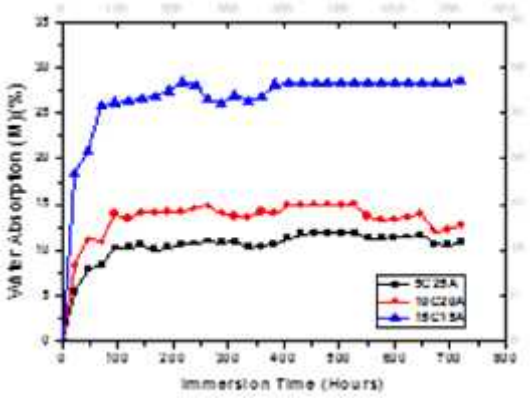

Fig. 6 Water absorption of agave and coir fibers hybrid composite

4. CONCLUSION

Coir-agave fiber reinforced hybrid polyester composite is a combination of two natural fibers as reinforcement of composite. Its mechanical properties was investigated. Result shows that by hybridization of coir and agave fibers as reinforcement of hybrid

composite, increasing content of agave fiber in the hybrid composite is increasing of tensile and flexural strength. Meanwhile, when volume fraction of agave fiber increased in hybrid composite, the water absorption also increased. SEM examination shows that the hybrid composite tend to undergo fiber pull out and matrix defect.

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