Afyon Kocatepe Üniversitesi Uluslararası Mühendislik Teknolojileri ve Uygulamalı Bilimler Dergisi

Afyon Kocatepe University International Journal of Engineering Technology and Applied Sciences

AKÜ IJETAS Vol **2(2)** (2019) Aralık (61-65 s) AKU J.Eng.App.Sci. **Vol 2(2)** (2019) December (61-65 pp)

Araştırma Makalesi / Research Article

e-ISSN 2667-4165 (https://dergipark.org.tr/akuumubd)

Kabak ve Jüt Liflerinin Mekanik Özelliklerinin Karşılaştırılması

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Geliş Tarihi:30.04.2019 ; Kabul Tarihi: 09.06.2019

Öz

Bu çalışmada, bitki esaslı lifler kullanılarak üretilen biyo-kompozit malzemelerin mekanik özellikleri karşılaştırılmıştır. Biyo-kompozit numunelerin üretiminde takviye elemanı olarak kabak lifi ve jüt kullanılmıştır. Üretilen biyo-kompozit numunelerin mekanik özelliklerinin karşılaştırılabilmesi için matris olarak epoksi reçine seçilmiştir. Mekanik özelliklerin belirlenmesi için eğilme deneyleri gerçekleştirilmiştir. Test sonuçlarına göre kabak lifi takviyeli kompozit numunelerin max. dayanımı 55 MPa jüt lifi takviyeli kompozit numunelerin max. dayanımı ise 36.5 MPa olarak ölçülmüştür. Ayrıca, Eğilme Modülü, kabak lifi için 5.7 GPa ve jüt lifi için 5.5 GPa olarak hesaplanmıştır.

Elde edilen sonuçlara göre kabak liflerinin – jüte göre daha yüksek mukavemet değerlerine sahiptir. Bu nedenle özellikle eğilme yüklerine maruz uygulamalarda Kabak lifleri tercih edilmelidir. Bu biyo-kompozit malzemelerin özellikle havacılık, otomotiv ve denizcilik sektörlerindeki potansiyel kullanım alanları için alternatif olabileceği öngörülmektedir. Bir sonraki çalışmamızda mevcut bitkisel liflerin mekanik özelliklerinin iyileştirilmesi ve geliştirilmesi çalışılacaktır.

Anahtar kelimeler
Kabak lifi, jüt lifi, biyo-kompozit, eğilme, eğilme dayanımı

Comparison of flexural properties of luffa and jute fibers

Abstract

In this study, the mechanical properties of bio-composite materials produced by using plant-based fibers compared. Luffa fiber and jute were used as reinforcement in the production of these bio-composite samples. To able to compare the mechanical properties of the reinforcement the same matrix (epoxy) was used in the production of all samples. Three-point bending tests were performed to determine the mechanical properties of these specimens. According to the test results, the Flexural Stress of luffa and jute fibers were measured 55 MPa and 36.5 MPa respectively. Also, Flexural Modulus calculated as 5.7 GPa for luffa and 5.5 GPa for jute fibers.

The strength of luffa fibers experimentally determined as obviously higher than jute fiber. Due to the high strength of luffa fibers should be preferred especially in applications that would be subjected to bending loads. Because of their design and strength characteristics of these green materials, it is envisaged that these materials could be an alternative for potential uses in aerospace, automotive and marine industries. We continue to work on the development of the mechanical properties of this kind of plant-based fibers in order to find a new alternative to glass fibers.

Keywords
luffa fiber, jute fiber, bio-composite, bending, flexural strength.

1. Introduction

In recent years, human beings have realized that if the environment is not protected, there will be a danger of the depletion of natural resources and the majority of areas producing fresh air. Chemical composites, which are widely used in many industrial fields, cause serious damage to nature due to the long years of recycling.
Therefore, the widespread use of recyclable bio-composite materials in the industrial field will be an important step for preventing damage to nature. In order to reduce the use of chemical fibers, researches on ecological fibers are carried out. In order to increase the application of environmentally friendly materials, not only new materials should be found, but also all characteristics of these materials must be defined and developed. That is why bio-composite materials have become the focus of many researchers in composite science in recent years.
Some researchers (Acharya, Mishra, Mehar, andDikshit, 2008; Balakrishnan, John, Pothen, Sreekala, andThomas, 2016; Caprino, Lopresto, andSantoro, 2007; Diharjo et al., 2013) draw the attention to the importance of this topic beginning with the question that Natural fibres: can they replace glass in fibre reinforced plastics? (Wambua and Verpoest, 2003).. For instance, Bodros and Baley (2008) and at all, use natural fibers reinforced thermoplastics, especially in the automotive industry. They set their major objectives as determining whether bio-composites would substitute for glass fiber reinforced polymer constructions analyzing the mechanic features of natural fiber and biopolymer composites.
Major bio-materials such as flax, jute, kenaf, and sisal analyzed in many studies. Although these materials have obstacles such as cultivation and continuity, their developed features gain great importance. Kocak and et al. (2008) according to the results of their study suggested that mechanic features of luffa fibers could be increased with the help of a chemical modification made using formic and acetic acid. The performance of natural fibers is attached to cellulose content. Luffa fibers, 63 percent of cellulose, 14.4 percent of hemicellulose, 1.6 percent of lignin, 0.9 percent of cinder and 20.1 percent of other materials. (Shen and et al. (2012) Besides, many studies Genc, 2015; Genc and Koruk, 2017; H. Koruk and Genc, 2015; Hasan Koruk and Genc, 2019) focused on the characterizations of plant-based fibers such as luffa fiber in the literature to understand the ability of application which can lessen the usage of chemical fibers.
In this research, producing bio-composites and comparing mechanic features are aimed using two types of herb-based fibers. In this context, luffa fibers grown on the South region of Turkey and jute fibers that imported from Bangladesh were used as reinforcement elements of natural fibers.
As a consequence, in consideration of obtained results from this research, the usage of recyclable bio-composite materials is going to be enlarged, and it is going to contribute to both industry and literature. At this point, it should be emphasized again that it is going to be used the same matrix (epoxy) while producing reinforcement elements (jute and luffa fiber) in order to compare them properly.
According to the results obtained in this study, some usage areas have been proposed for bio-composite materials. By, it is aimed in this study that to produce and develop a product which is both easy to produce in our country with its potentials and possible to recycle.

2. Materials and Methods

In this research, luffa fibers and jute have been used as reinforcement elements. The raw Jute that used was woven with 0 °/90 ° fiber arrangement. It is imperative to use the same matrix when comparing the properties of natural fibers with chemical fibers. Therefore, epoxy resin (DURATEK 1200) was used as a matrix to produce the composite samples.

To produce Luffa Fiber Reinforced Composite (LFRC) prepared 4 layers dry luffa fiber and to produce Jute Fiber Reinforced Composite (JFRC) prepared 10 layers dry jute fiber. These materials weighed using a scale, and their dry weight measured. Then, these fiber layers moulded by hand lay-up method and epoxy matrix added for curing step. To able to prepare curing conditions press machines that controlled by PLC (Programmable Logic Controller) used and the curing conditions set to 5 Bar and 120 ° C degree during 100 minutes.

Produced bio-composite specimens shown in Figure 1 were cut using the CNC Router according to the standard (ISO14125, 1999).

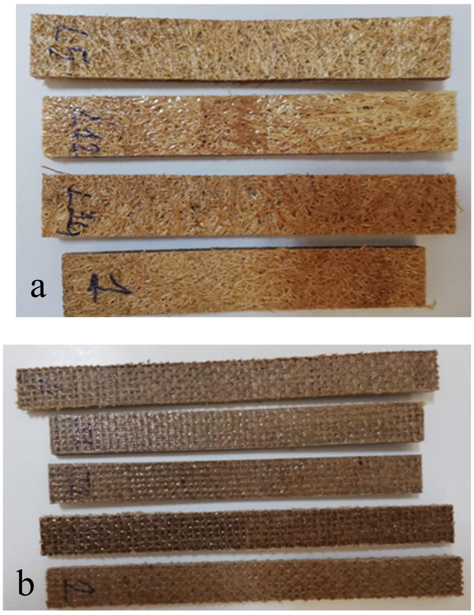

Figure 1. Composite samples for three-point bending test a) luffa composite samples b) jute composite samples

LFRC specimens were cut in two directions, Longitudinal (L) and Transverse (T) direction. Herewith, the flexural properties were determined in two directions. Also, JFRC specimens were cut in the fiber directions.The dimensions and volume fraction values of bio-Composite samples for three-point bending test are given in Table 1 which prepared according to the standard (ISO14125, 1999). The properties of the bio-composite material samples are shown in Table 1. The density of dry luffa fiber, jute fiber and epoxy resin used was 71.1 kg/m^3, 389.5 kg/m^3, 1100 kg/m^3, respectively. These values used to calculate the volume fraction of composite by the rules-of-mixtures method.

Table 1. The dimensions and volume fraction values of samples

Materials	Code	Dimensions			Weigh	Volum
		b	L	T	W	e
LFRC	T1	15.0	80.0	4.0	3.4	0.6
LFRC	T2	15.0	81.0	4.0	3.2	0.7
LFRC	T3	15.0	81.0	4.0	3.4	0.6
LFRC	T4	15.0	81.0	4.0	3.4	0.6
LFRC	L1	15.0	80.0	4.0	3.6	0.6
LFRC	L2	15.0	80.0	4.0	3.6	0.6
LFRC	L3	15.0	80.5	4.0	3.6	0.6
LFRC	L4	15.0	80.0	4.0	3.6	0.6
JFRC	J1	15.0	126.0	4.2	8.6	0.6
JFRC	J2	15.0	126.0	4.2	8.8	0.6
JFRC	J3	15.0	126.0	4.0	8.8	0.6
JFRC	J4	15.0	126.0	4.3	8.6	0.6

3. Three-Point Bending Test

Three-point bending tests were performed to determine the mechanical properties of bio-composite specimens as shown in figure 2.

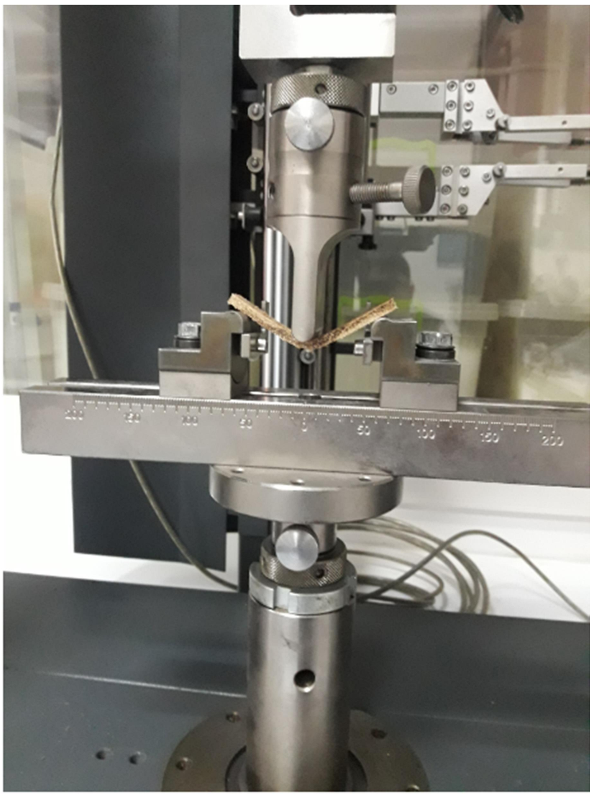

Figure 2. Bending test for bio-composite specimens

Three-point bending test performed according to the standard (ISO14125, 1999). Then, measured values used to calculate the flexural strength of the specimens using equation 1.

$$\boldsymbol{\sigma = \frac{3FL}{2bt^2}} \qquad \text{Eq.1}$$

F is the maximum load (N), the distance between the L supports is (mm), b is the width (mm), and t (mm) is the thickness.

The Flexural Modulus was used to evaluate the stresses obtained. The Flexural Modulus was calculated using equation 2.

$$\boldsymbol{E} = \frac{\boldsymbol{L^3}}{\boldsymbol{4bh^3}}\left(\frac{\boldsymbol{\Delta F}}{\boldsymbol{\Delta s}}\right) \qquad \text{Eq.2}$$

4. Results and Analysis

Flexural Strength and Flexural Modulus

In this part of the study, the elastic modulus was calculated to evaluate the bending strength of the samples and the samples. Bending strength was calculated for LFRC and JFRC samples.

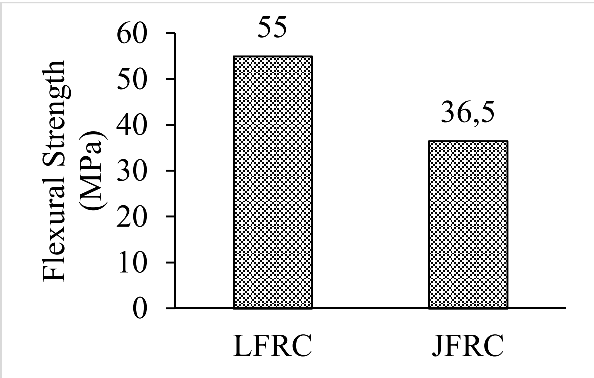

Figure 3. Flexural strength for LFRC and JFRC bio-composite specimens

Flexural strength for LFRC and JFRC were calculated according to the standard as shown in Figure 3.

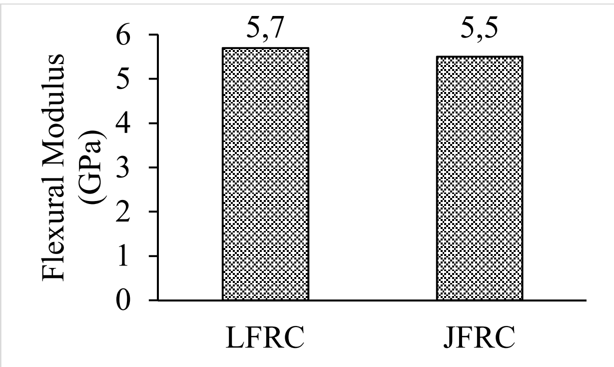

Figure 4. Flexural modulus for LFRC and JFRC bio-composite specimens

Besides, flexural modulus for LFRC and JFRC were calculated according to the standard as shown in figure 4.

5. Conclusion

According to the test results, the Flexural Strength of LFRC was determined higher than JFRC. Due to the high strength of LFRC, especially in applications that are subject to bending loading, these type bio-composites could be preferred. Because of their design and strength characteristics of these green materials, it is suggested that this kind of bio-composite materials can be alternative materials, especially for automotive and aerospace industries usage areas. We continue to work on the development of the mechanical properties of this kind of green fibers in order to find a new alternative to glass fibers.

Acknowledgment

The author(s) disclosed receipt of the following financial support for the research: The authors gratefully acknowledge the funding provided by Marmara University, Scientific Research Projects Committee with grant number FEN-C-YLP-121218-0615.

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