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Hermetical Alkali Digestion of Kenaf Bast Fibres

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Abstract

Creating a hermetic alkali digestion method to separate single cellulosic fibres from kenaf bast was the aim of this investigation. Kenaf bast were hermetically processed into single fibre for an hour at four different temperatures using a sodium hydroxide solution.The elimination of lignin and hemicelluloses during the hermetical digesting procedure used in this study resulted in fibres with high cellulose content. the fibers's digested surface hardness and elastic modulus. Were vastly improved as compared to those that had been digested. As the digestion temperature increased, the tensile modulus and tensile strength of the individual fibres decreased. When the fibres were digested, micropores were created in the cell walls of the fibres. Studies on composite materials comprised of polypropylene reinforced with digested fibres showed that there was poor compatibility between the digested fibres and polypropylene matrix.

Keywords: Digestion process; Polypropylene; Fiber cell wall; Hemicelluloses; Lignin

Introduction

The Malvaceae family, which is a subgroup of the Magnoliophyta, includes the agricultural product kenaf. The cultivation of kenaf dates back to prehistoric Africa. In only 4 to 5 months, kenaf can grow to heights of 12 to 14 feet. Kenaf is mostly grown in Mississippi, Texas, California, and other states in the United States. Each acre of kenaf produces six to eight metric tonnes of bast and core yearly.

Cellulose, hemicelluloses, and lignin make up the bulk of lignocellulosic fibre. The cellulose fibrils are held together by noncellulosic compounds like lignin, hemicelluloses, and pectins. The amount of cellulose in the lignocellulosic fibre affects the reinforcing effect. Usually, chemical retting can be used to produce materials with high cellulose content. The process of turning agricultural stalks, particularly those from bast crops, into fibres is known as retting. Lignin is often removed by alkali treatment in the pulp and paper industries. By separating the fibre bundles, individual fibres can be obtained using the alkali digestion process. The use of the individual fibres as reinforcements makes it simple to create a homogeneous fibre distribution in the polymer composites. Additionally, the creation of micropores in the fibre creates areas for subsequent fibre treatments such nanoparticle impregnation and other processes [1, 2].

This study set out to analyze the reinforcement effects of the digested fibres in polymer composites and investigate the impact of four digestion temperatures on the properties of kenaf bast fibres in a hermetically sealed alkali digestion process.

Processing of lignocellulose fiber-reinforced polymer composites has been plagued by compatibility between the fibre surface and polymer matrix. The kenaf fibres that were retted using an alkaline solution by a hermetic method exhibited poor compatibility with the polypropylene matrix, as was reported in the first publication of this series, leading to delamination of the composites. Coupling agents are frequently used to increase compatibility between cellulosic natural fibres and the polymer matrix. However, the organic coupling agents are typically expensive and raise issues for the environment. According to earlier research, the nanoparticles that were deposited on the fibre surface acted as nucleation sites to start the liquid polymer matrix's crystalline orientation. As a result, a correct procedure for adding nanoparticles to fibre surfaces that act as manipulators of the attraction force for polyolefin matrixes has the potential to enhance the development of crystals in the polymer matrix. The characteristics of the composites should be improved because the adhesion between the reinforced fibres and the matrix substantially influences the mechanical behaviour of a composite material.

The word "water absorption" can be understood in one of three ways: by water diffusing into the matrix directly, by interphase reinforcements and matrix, or by flaws like pores and cracks. When water enters polymers, it can take on a number of different forms, including bound water, which exhibits a strong contact between the molecule and the matrix, and free water, which is found in capillaries and tiny cavities inside the polymer.When moisture permeates composites, it weakens the link between the fibers and the matrix, lowers the glass transition temperature, causes the matrix to swell, plasticize, hydrolyze, and occasionally microcrack. Despite the fact that materials' mechanical qualities can deteriorate due to water absorption, redrying can assist the materials restore some of their properties. In general, variables including the weight fraction of the fibre, the volume of the void, the matrix's viscosity, the chemical treatment of natural fibre, humidity, and temperature affect how much moisture diffuses through a composite [3-5].

Materials and Method

We bought kenaf stalks from MSU North Farm.As a digestive aid, sodium hydroxide solution made with NaOH beads and purified water was used. As a pH adjuster, glacial acetic acid was employed. The laminated kenaf fiber-PP composites were made using polypropylene film, which was supplied by Plastic Suppliers, Inc. in Dallas, Texas. Every experiment was carried out twice, and all of the results are averages of two different readings.

In a separate experiment, serum and plasma were digested as previously described for subjected to mass spectrometric analysis. To better understand how much protein is digested, the sequence coverage

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of three model proteins, albumin, haptoglobin, and serotransferrin, was measured and compared.

Long fibre bundles that could be digested were present. For five minutes, these fibre bundles were manually split using a blender. It was possible to scatter the broken fibres in water and create homogenous fibre sheets. The digested fibres could be directly converted into homogeneous fibre sheets without further mechanical separation and had a better dispersion in water. The fibres were first thoroughly stirred into water before being used to make sheets of fibre. After that, the suspension was run through a screen, where the fibre sheets were created. The fiber sheets were dried. The fiber sheets and polypropylene films were and layered in alternate fiber directions. The fibre to polypropylene weight ratio. Hot pressing was done on the laminated mats at a certain temperature and pressure. Until the platen reached room temperature, the pressure was not released. Prior to preparing the specimen for mechanical testing, the laminated kenaf fiber/PP panels were taken from the press and kept in a desiccator for two days. Each type of digested fibre received three panels [6-8].

Discussion

TGA was used to examine the impact of carbon fibre hybridization on the thermal stability of woven kenaf composites. The temperature at which decomposition begins, the temperature at which it peaks, weight loss, and the portion of the material that is not volatile, or residual material, were all determined using the TG and DTG curves. In the meantime, DSC was employed to characterise transitions, such as melting and crystallisation, in the woven kenaf/carbon fibre hybrid composite, with the function of fabric design and fabric density.

Overall, the results show that across all the various types of matrix, the kenaf fibre treated with NaOH had the highest debonding force prior to fibre breakage/debonding. The NaOH treated kenaf fibre comes next, producing the second-highest average load. Surprisingly, when the fibres were treated with HCl, the maximal debonding force was modest for all tested matrices. The greatest debonding force significantly decreased as HCl concentration increased.

Cinnamate 4-hydroxylase and ferulate 5-hydroxylase are two P450s that catalyse processes along the general phenylpropanoid route in plants. F5H is a member of the P450 CYP84 family, whereas C4H is a member of the P450 CYP73 family. Two F5H homologs were found in the Arabidopsis genome after the first definition of Arabidopsis F5H as CYP84. In numerous plants, including Arabidopsis, Liquidambar styraciflua, and Brassica napus, AtF5H1 is now well characterized. Since AtF5H2 is a more distinct member of the CYP84 family, no other plants have any genes that are quite similar to AtF5H2. In Brassica napus, three F5H homologs have been discoveredBnF5H1 and BnF5H2 exhibit strong identification with AtF5Hs and share many similarities. As a result, it is assumed that BnF5H1 and BnF5H2 are part of the same group. Although BnF5H3 exhibits a high degree of similarity to the corresponding part, it is deficient in the codon for proline at position S that is found in other F5H genes [9-11].

Conclusion

Lignin and hemicelluloses were successfully extracted from kenaf bast fibres using a hermetical alkali digesting technique. The fibres' cellulose content. Improvements were seen in the fibre digested' s elastic modulus and average surface hardness. The fibre surface hardness and elastic modulus improved as a result of the increased cellulose content of the digested fibres. The tensile modulus and tensile strength characteristics of the fibre were significantly influenced by the digesting temperature.

Fibres from kenaf bast were successfully impregnated with inorganic nanoparticles. The deposition of nanoparticles on the surfaces of the fibres is evident in the SEM pictures. The elastic modulus and surface hardness of the fibre were both improved by INI treatment.Tensile strength was increased in the fibres that underwent INI procedures. To determine the ideal weight fraction of kenaf fibre, biocomposites of short kenaf bast fibre reinforced in cardanol with various fibre loadings were evaluated.

Conflict of Interest

None

Acknowledgment

None

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