CHEMICAL TREATMENTS OF MOROCCAN SISAL FIBER FOR MECHANICAL APPLICATIONS ON BIOCOMPOSITES

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Abstract

This article aims to valorize the Moroccan plant agave sisalana from the southern region by studying the influence of chemical treatment on the mechanical properties of the sisal fiber for application in technical textiles.

Tensile and moisture absorption tests to study the influence of the treatment on the physical and mechanical properties.

The results obtained are very interesting to show the classification of the Moroccan sisal fiber in relation to the sisal fiber of other countries as well as a strong potential in the reinforcement of the composites.

Methodology

Treatments of sisal fibers

First, the sisal fibers were extracted with water for 2 hours at 80°C, and then dewatered to remove surface debris and mineral salts.

Then, the sisal fibers were immersed in a 3% NaOH solution at 70 °C for 3h, the fibers were washed with distilled water several times and neutralized with a diluted acetic acid solution to neutralize the excess of NaOH, the fibers were then dried in an oven at 60 °C for 6h.

In order to increase the moisture absorption capacity and improve the hydrophilic behavior, the sisal fibers were treated with a $NaClO_2$ solution with different mass concentration (0.5%-1%-1. 5%) at 80°C for 2h, then washed with distilled water and dried at 60°C for 24h. The fibers are then treated with a solution of $KMnO_4$ with different concentration (0.3%-0.6%-0.9%) in 3% acetone for 15min, the treated fibers were placed in a water bath at 60°C for 1h30 after washing with distilled water and dried at 60°C for 24h.

Context

The production of synthetic fibers is constantly progressing and gaining market share over their natural fiber competitors [1]. Unfortunately, synthetic fibers have a negative impact on the environment due to the manufacturing process is considered energy intensive and highly polluting. Moreover, it is mainly based on non-renewable petroleum resources [2]. Natural fibers such as hemp, kenaf, palm, date palm, bamboo, jute, sisal combine several advantages such as availability, biodegradability and low cost, however they have disadvantages such as high moisture content, fiber swelling, low thermal stability, low adhesion to the matrix yarn, and high stiffness.

Fortunately, these limitations can be overcome by chemical treatments that are used to remove hydrogen bonds from the cellulosic fiber, decrease the roughness of the fiber surf ace and remove surface debris in order to strengthen the polymer matrix .

Results

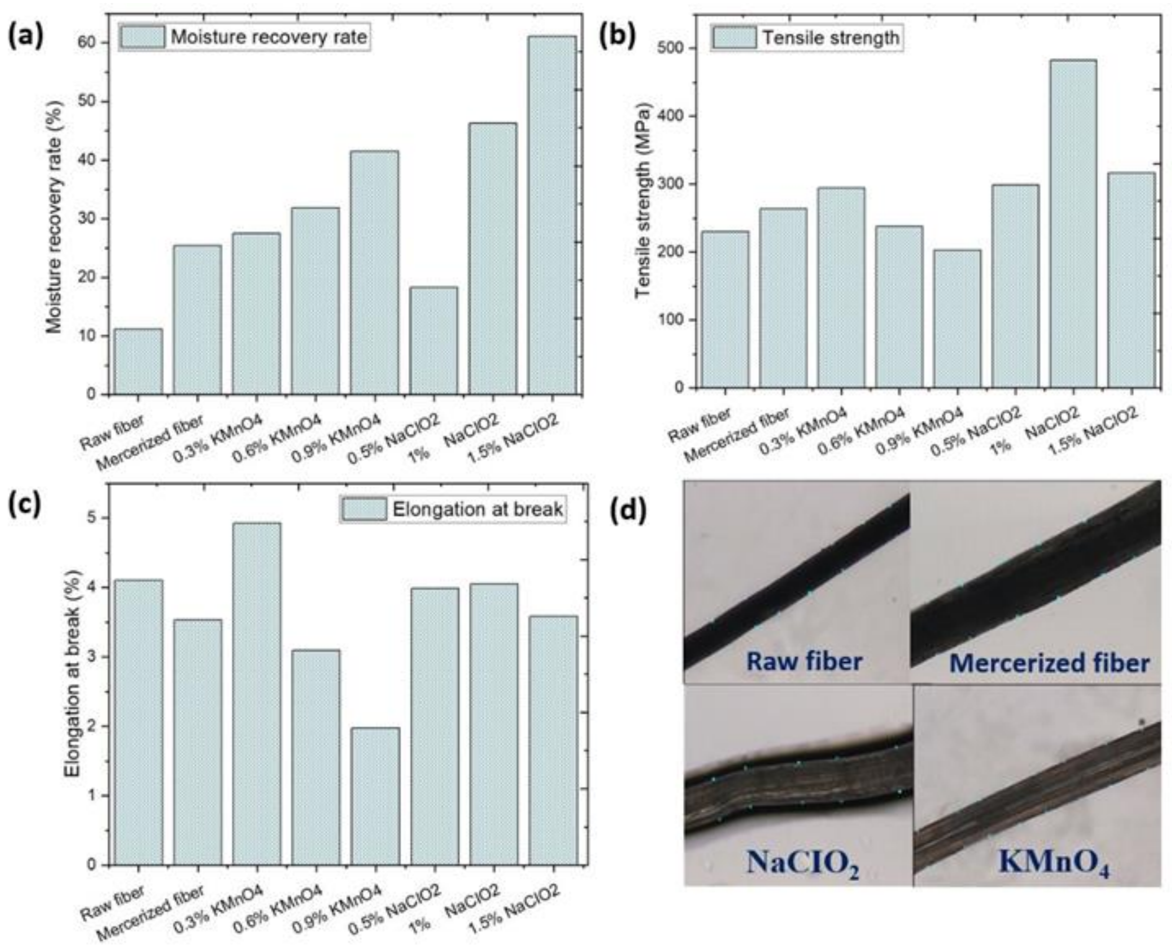

Fig 1. Effect of fiber treatment on :a- Moisture recovery rate (%); b- Tensile strength; c- elongation at break (%); d- Microscopic images of raw and treated fibers

Conclusion and perspectives

Sisal fibers represent an attractive solution to reinforce composites, the main objective of our work was to improve the moisture absorption and mechanical properties of sisal fiber to produce band-wrapping composites in different spectroscopic differences . The results showed that the treatments reduced the impurities located on the fiber surface and increased the surface area .

Comparing the two treatments, the best results in terms of mechanical properties were 482.4 ±6 MPa and a moisture absorption of 46% for 1% $NaClO_2$; on the other hand, the maximum tensile strength of the fibers treated with 0.3% $KMnO_4$ was 294.67 ±5MPa and a moisture absorption of 27%.

The treatments we have undergone which will be useful to reinforce biocomposites for the manufacture of packaging, the following objective to better justify the interfacial movement between the fibers and the matrix during the application of tensile stresses and identification of the dielectric properties of the composite plates made

References

1 Gutiérrez, A., Rodriguez, I. M., & Jose, C. (2008). Chemical composition of lipophilic extractives from sisal (Agave sisalana) fibers. Industrial crops and products, 28(1), 81-87.

2 Usman, M., Jahanger, A., Makhdum, M. S. A., Balsalobre-Lorente, D., & Bashir, A. (2021). How do financial development, energy consumption, natural resources, and globalization affect Arctic countries' economic growth and environmental quality? An advanced panel data simulation. Energy, 122515.