TENSILE STRENGTH TESTS IN POLYESTER COMPOSITES WITH HIGH INCORPORATION OF MALVA FIBERS*

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Abstract

The modern composite materials, especially those reinforced with synthetic fibers such as glass and carbon, have been used since last century to attend the demands required by most technological fields, from home appliances to aerospace. Natural fibers composites with biodegradable polymer matrices are considered environmentally friendly materials and currently accepted as possible substitutes for synthetic composites. These green composites can be safely discarded or composted at the end of their life without harm to the environment. Another alternative for synthetic composites is to apply natural lignocellulosic fibers as reinforcement of conventional polymer matrices and already used in the automobile industry. In addition to the environmental and societal advantages of the green composites, the lignocellulosic fiber reinforced conventional polymer composite also has economical and technical advantages. In the case of a fiber collected as a waste, the price of the composite can be considerably lower than “fiberglass”. Furthermore, with high strength lignocellulosic fibers such as sisal, ramie and malva the specific strength of a composite may approach that of “fiberglass”. Therefore the objective of the present work is to investigate the mechanical behavior of polymer matrix composites reinforced with high volumes of natural malva fibers subjected to tensile stresses.

Keywords: Malva fibers, Polyester matrix, Tensile strength tests.

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1 INTRODUCTION

The natural fiber extracted from the stem of malva plant, (*Urena lobbata, Linn*), are currently among the most studied natural fibers, mostly because of its mechanical performance associated with high tensile strength and flexural strength. It is known that with the increase of fibers volume fraction the composite significant increases its tensile strength. This was obtained with amounts up to 30% in volume of malva.
However no higher volume of fibers was able to be molded in a composite plate until now. Thus the present work aims to study the influence of higher volumes of fiber on the tensile strength of specimens prepared under 5 tons of pressure. The fibers were previously washed and dried in an oven at 60ºC, after that poured together |with the polyester resin and catalyst mixture in the metal molds bone-shaped, and pressured pure specimens quality [1-5]. The tensile strength increased significantly with higher amounts of malva fiber incorporated in the polyester matrix. This better performance can be directly related to the fracture obstacle imposed by the fibers as well as the type of cracks resulting from the fiber/matrix interaction [6-7].

2 MATERIAL AND METHODS

The materials used in this work were malva fibers was donated by a producer, Companhia Castanhal do Pará, from the North region of Brazil and commercial polyester , in figure 1 it can be seen the malva plant and the as-received bundle of fibers.

(A) (B)

Figure 1: Malva typical plant (A), and extracted fibers (B).

The fibers were dried at a temperature of 60°C to prevent excessive moisture. The malva fiber had already presented a tensile of 1000MPa and has a diameter distribution of 0.020 – 0.110 mm, with an average of 0.065 mm.
The fibers were placed aligned in a steel bone-shaped mold, the volume fraction of fiber used in this work was increased from 0 up to 50%. Onto the fibers the still fluid polyester resin was poured into the mold. During this process particular care was taken to avoid air bubbles in the samples. Then the system was subjected to gradual increase of pressure from 0.5 to 5 tons which was relieved only after 24 hours at room temperature to make sure that the samples was not uncured.
Than the samples were buffed to improve the surface quality. The dimensions of the samples were measured and catalogued to make possible further analysis. After that the samples was submitted to a tensile test in a Instron machine model 5582, with a strain rate of 4,2 x $10^{-4}s^{-1}$ in controlled temperature environmental at 25ºC.

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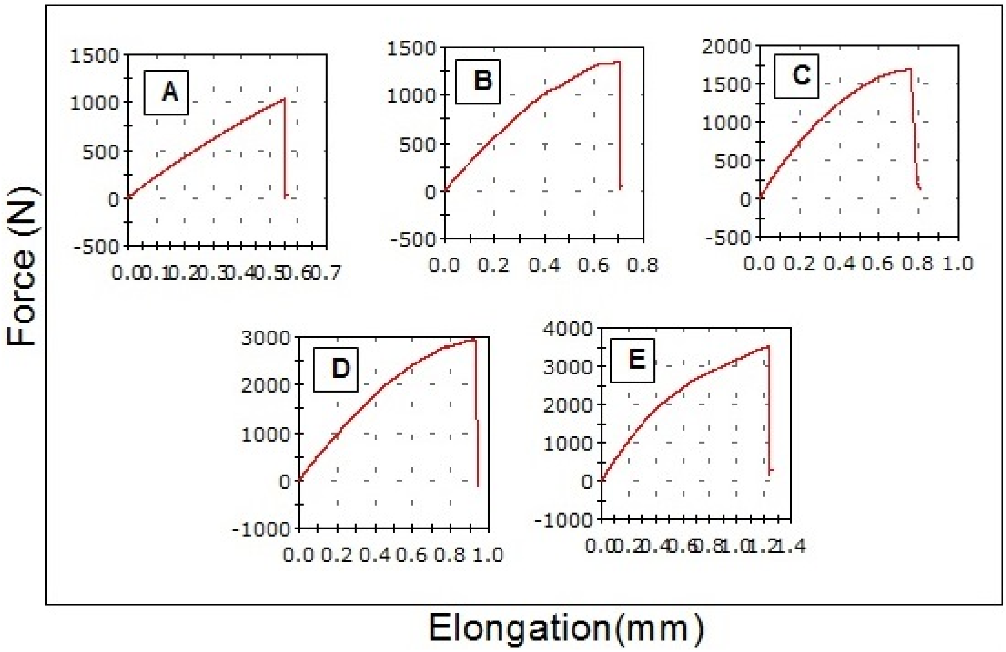

Figure 2: Curve Load versus Extension of traction for a sample with (A)10%, (B) 20%, (C) 30%, (D) 40% and (E) 50% of malva fiber incorporated.

3 RESULTS AND DISCUSSION

The table 1 shown the results of tensile strength for the composites incorporate with the corresponding volume of fiber incorporated. Also, the figure 2 contains the plotted curve based on these results.

Table 1: Tensile strength of the corresponding sample volume fraction of fiber

Volume fraction of fiber (%)	Tensile strength (MPa)
0	41,33 ± 4,77
10	53,29 ± 8,44
20	63,33 ± 6,35
30	86,94 ± 9,92
40	93,88 ± 7,79
50	104,79 ± 9,09

Table 1 and figure 4 shown that occur a very high enhance when the volume fraction of fiber is increased. It can be seen especially when compared the results of pure polyester (0% of volume fraction of fiber) and the high volume of fiber incorporated (50%).
Figure 3 illustrates the macro aspect of tensile ruptured specimens corresponding to the different volume fraction of malva fibers. In this figure, the fracture of neat polyester specimens tends to be transversal to the tensile axis but with the increase of malva amount the evidence of malva fiber participation could be detected. What indicates that the fracture mechanism for the pure polyester matrix was mainly associated with the propagation of transversal cracks although for the composites the non-transversal crack indicates a low interface relation between the malva fiber and the polyester matrix [8-10].

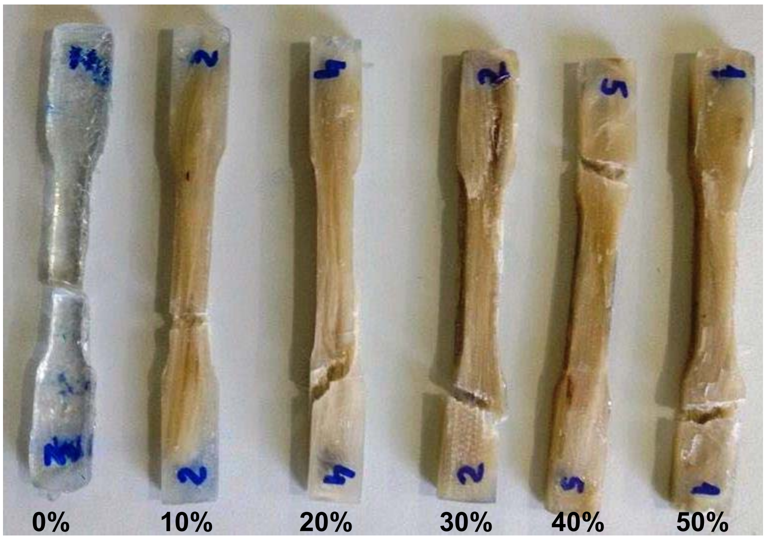

Figure 3: Typical tensile ruptured specimens volume fraction of malva reinforced polyester composites.

However is wise to notice that the deviations of some of these results are significant. It can be explained by the difficulty of prepare samples uniformly. Also it can be explained by the irregular surface of the natural fibers which causes irregularities on the interface between the fiber and polymer [11].

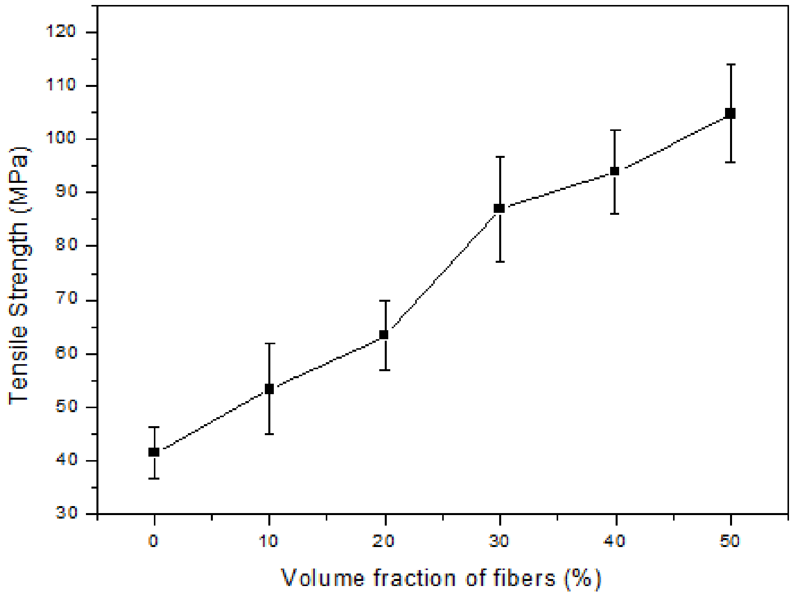

Figure 4: Tensile strength with malva fraction in polyester composites

Another explanation of the weak interface is because of the natural fibers are hydrophilic and the polymer matrix is hydrophobic. Therefore, even after drying in the oven, these fibers always have residual surface moisture which difficult the adhesion between fiber and matrix [12].
This kind of deficiency can be solved improving the techniques of preparation of the samples by taking extra care with the process of putting fibers and resin on the mold. Also the pressure it the system was submitted improve the interface between fiber and matrix which leads to superior materials.

4 CONCLUSION

- The increase amount of fibers have directly influence of the mechanical behavior of composites reinforced with natural fibers. An increase of the mechanical property occurs in higher volume of fibers incorporated.
- The samples studied in this work they had properties improved with the pressure which these were submitted.
- The high pressure fabrication process in a steel mold enabled the high volume specimens fabrication what can explain the superior result of the material because of its brittle interface fiber and matrix.

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