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WEIBULL ANALYSIS OF DENSITY MALVA FIBERS WITH DIFFERENT DIAMETERS[1]

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Abstract
This work aims to analyze the variation of density in comparison with checking the diameter of the fibers, using Weibull statistics. These fibers obtained from plants introduced to Brazil in the states of Amazonas, Pará and Maranhão, demand for their rapid and satisfactory, a hot and humid climate as alternating periods of sun and rain in the Amazon. Malva fiber (Urena lobata, L) is a fiber Liberian occurring between the exchange layer that surrounds the central bone woody stem and the outer layer extracted from a plant annual textile presenting a great similarity to the chemical composition of jute. The fiber diameter is measured with a profile projector and the results analyzed by the method of Weibull to demonstrate the relationship between the diameter / Malva fiber density.
Key words: Malva fiber; Weibull analysis; Density.

ANÁLISE DE WEIBULL DA DENSIDADE DE FIBRAS DE MALVA COM DIFERENTES DIÂMETROS

Resumo
Este trabalho tem por objetivo analisar a variação da densidade, em verificação comparativa com o diâmetro das fibras, usando a estatística de Weibull. Estas fibras, obtidas de plantas introduzida no Brasil, nos estados do Amazonas, Pará e Maranhão, requerem, para seu crescimento rápido e satisfatório, um clima quente e úmido como os períodos alternados de sol e chuva da Amazônia. A fibra de Malva (Urena lobata,L), é uma fibra liberiana ocorrendo entre a camada do câmbio que envolve a medula central lenhosa do caule e a camada externa extraída de uma planta têxtil anual, apresentando bastante semelhança à composição química da juta. O diâmetro das fibras será medido com um projetor de perfil, e o resultado analisado pelo método de Weibull deve demonstrar a relação entre o diâmetro e a densidade das fibras de Malva.
Palavras-chaves: Fibras de Malva; Análise de Weibull; Densidade.

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1 INTRODUCTION

The environmental degradation generated every minute by the accelerated development of our planet, brings the consequent responsibility to increase the reality of many organizations and environmental purposes with attitudes, we know that the engagement is scientific fundamental value for this type of evolution and that awareness can only be held if science generate technological subsidies needed to stop not in society.
Countless are the studies that seek to build “green” materials or environmentally correct, who are able to replace finite matter or pollutant, among these searches some call us the attention by the creative initiative, for simplicity or even by the ingenuity, such as alcohol, which replaces the gasoline, Biodiesel, which is a compound of vegetable oils and alcohols which aims to replace the Diesel, and the use of composite materials to replace the hardwood extraction.
Natural fibers are examples of environmentally friendly materials and are increasingly being considered for employment in engineering even as reinforcement of composite materials.(1)
Modern technology is advancing ever faster and the required properties are harder to obtain, to solve this problem, the centers of research in materials generated ways of joining materials with very different characteristics in one material, this mixture or union bears the name of the composite, which is nothing more than a material "engineered" in the search for specific properties.(2) Many composite materials are composed of only two phases to the matrix and the dispersed phase, and the main properties of the composites are due to its dispersed phase.
The idea of a deeper study of the types of composites is to verify the theoretical feasibility of adding fibers to an array with any purpose to achieve the strengthening of the material in the quest to make a more rigid material and its resistance Mechanical.(3) A clear example of this type of natural Malva fibers. The Malva is an annual textile plant of rapid growth and satisfying the ecological character of benefit to the environment, introduced in Brazil in the states of Amazonas, Pará and Maranhão and its chemical composition closely resembles the jute.
The Malva can be used in several segments: manufacture of woven fabrics, mats, strings and string, but also can produce the cellulose for the production of paper currency, due to its resistance also can be used in the manufacture of hoses, tires, wire parachute, the manufacture of sacks for packing products such as sugar, coffee, cashew nuts and cocoa.(4) This work will be done at first statistical analysis of the second fiber Weibull, where data will be collected as average density and average volume of these fibers with different diameters.(5)

2 MATERIALS AND METHODS

For this study, we used Malva fiber (*Urena lobata, L*). The Malva is a Liberian fiber occurring between the layer of the exchange involving the spinal central woody stem and the outer bark grown in Northern Brazil. It is classified in group ligno-cellulosic fibers, together with the jute fibers, kenaf, rosella etc. Figure 1 illustrates the initial phase, as well as the appearance of Malva fibers.
Is one of the fibers less studied until the present day, which should generate unprecedented results in the verification of properties and characteristics.(6)


Figure 1. (a) Malva initial phase; (b) e (c) Malva fibers industrial production.

In Figure 1a, there is naturally occurring in the Amazonas region.
In Figure 1b, the fibers have been manually removed from the stem dried with a sharp blade. The longitudinal direction of the fiber coincides with the stem and corresponds to the direction of natural cellulose Malva fibers.
Figure 1c shows different diameters were obtained cross section the phase of industrial production to supply the demand of the consumer market.
Batch received, 100 fibers were selected randomly to one dimensional statistical analysis. In Figure 2 shows the statistical distribution of an equivalent diameter measured by a profile projector model PJ3150 Pantec along the fiber length in five separate locations, and their weight measured on a precision scale in own laboratory
Natural fibers have a basically circular cross section, so that to perform the calculation of the density, and average density of each fiber was obtained from results of the cylinder volume utilized to the Equation 1.

$$\rho = \frac{4m}{\pi d^2 l} \qquad (1)$$

Where m = mass; d = diameter; l = length; and ρ = density.
The values obtained for the density (ρ) was read by a computer program according to the Weibull statistical analysis.

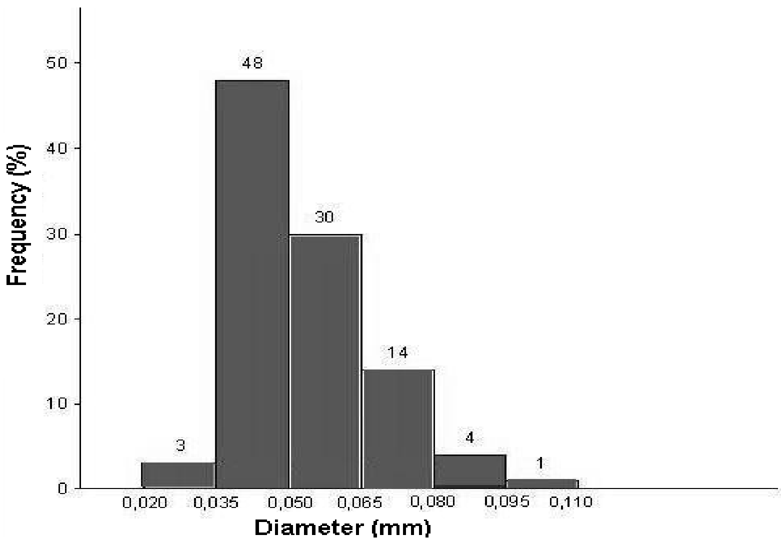

Figure 2. The frequency distribution of Malva fibers diameters (%).

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The histogram in Figure 2 shows the frequency distribution of Malva fiber diameters used in this study. Based on this histogram, an average diameter of 0.065 mm was calculated in the range 0.02 mm to 0.11 mm

3 RESULTS AND DISCUSSION

Based on the values of weight and volume, a density value was obtained for each fiber, and then these values were statistically analyzed using the Weibull method for the fiber 20 associated with each of the sixth diameter ranges shown in histogram of Figure 2.
Through the program Weibull analysis, makes it clear that the first 4 intervals diameter all plots in Figure 3 are unimodal, that is, a single straight line fits the points in each range, indicating a similar behavior of fiber density, within the range of same diameter. It is also observed that the last two tracks with larger diameters, the occurrence of a small increase in the dispersion density
In addition, the program also provides the corresponding density characteristic (θ), the Weibull modulus (β) and the adjustment precision parameter (R2). The values of these parameters and the average density is related to statistical deviations, based on the Weibull distribution, and are presented in Table 1.

Table 1. Parameters Weibull density malva fiber associated with different diameters

Diameter Intervals (mm)	Weibull Modulus β	Density Characteristic θ(g/cm3)	Adjustment Precision R^2	Average density (g/cm3)	Statistical Deviation (g/cm3)
0,020–0,035	6,077	0,8865	0,9662	1,11	0,2134
0,035–0,050	5,890	0,9553	0,9651	1,035	0,204
0,050–0,065	9,190	0,8636	0,9293	1,051	0,136
0,065–0,080	10,160	0,8423	0,9337	1,046	0,124
0,080–0,095	8,709	0,9489	0,8886	1,026	0,140
0,095–0,110	14,30	0,9997	0,9259	1,045	0,089

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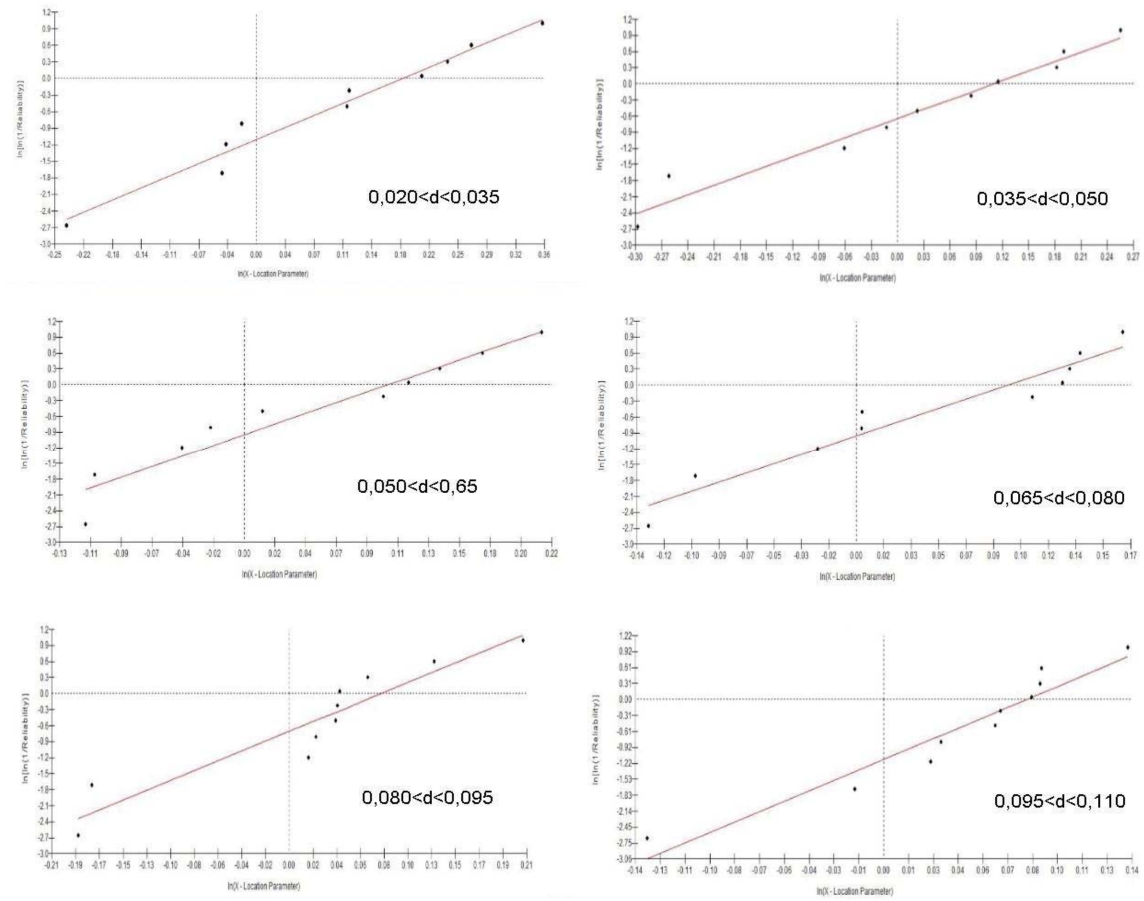

Figure 3. Weibull graphs for different intervals in the histogram of Figure 2.

The density variation characteristic with the average fiber diameter for each of the intervals is shown in Figure 4. In this figure there is a clear trend for the parameter θ varies with the malva fiber diameter. This means that the fiber density is an undefined parameter, presenting as seemingly random

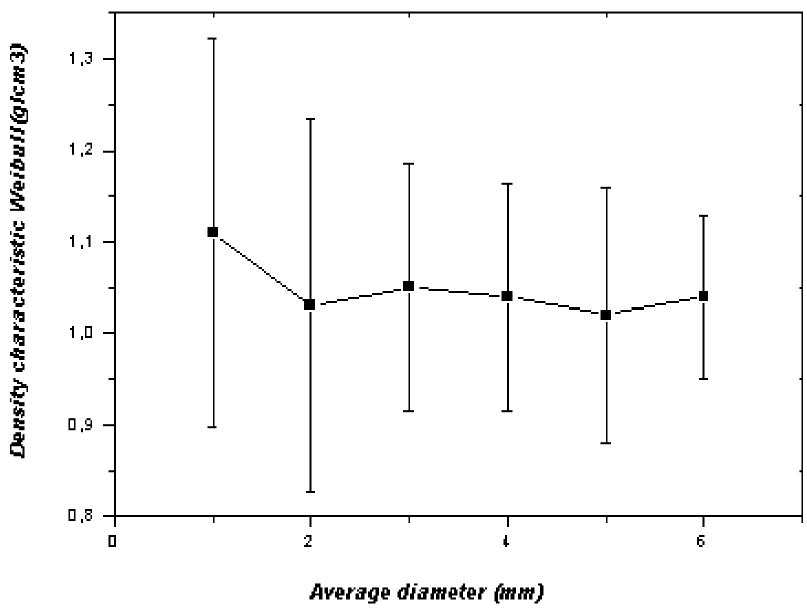

Figure 4. Density variation characteristic with the average diameter ranges in accordance with different malva fiber diameters as graphics on Figure 2.

Analyzing the physical meaning of the behavior of Figure 4, the average density for this study evaluated the malva fibers was plotted as a function of the diameter in Figure 5.
In Figure 5 there is also a correlation between independent d and D, where the error bars (statistical deviations) are very close to each other, comprising within the same range values, demonstrating that the fibers appear to have the same density, irrespective of diameter within investigated limits.(7)
Considering the wide dispersion (error bars) in the values of the volumetric mass in Figure 5, which is due to heterogeneous characteristics, and randomization of the biological process of formation of a lignocellulosic fiber,(8) such as malva fiber this work.
As a result, it is only possible to consider a line passing within the error bars as a best correlation between D and d is thus shown that the density does not vary with the diameter, with a single value between 1.084 g/cm^3 and 1.20 g/cm^3. It is therefore appropriate to consider the values of D in Figure 5 are approximately constant, about 1.0433 g/cm^3, for all fibers.

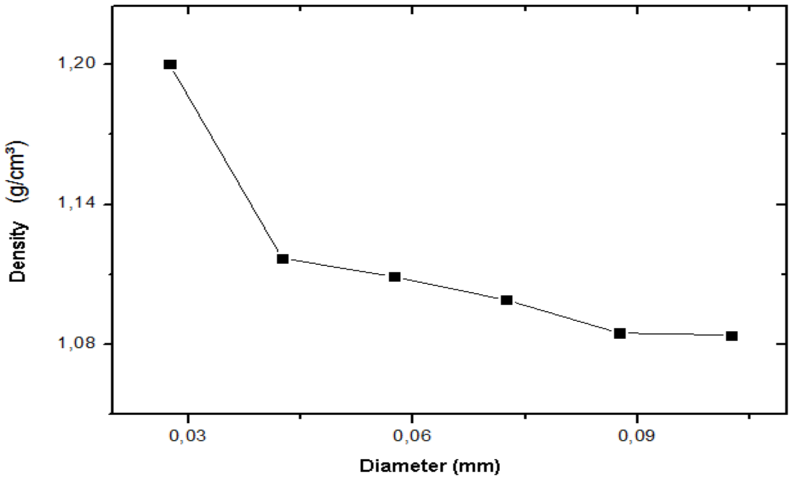

Figure 5. Variation of the density characteristics, diameter of each interval in Figure 2.

On the basis of Figures 4 and 5, it is suggested that these malva fibers, present a different behavior in comparison with the density of other lignocellulosic fibers,(9,10) where a hyperbolic type of mathematical equation is a correlation between the best properties
As a final remark, it must be mentioned that the value of constant density of the malva fibers, will in practice on a random selection of fiber reinforced composites malva to effectively polymer with improved mechanical properties, which makes this process very easier.

4 CONCLUSIONS

- In this work, the Weibull statistical analysis of the density of malva fibers, showed a ratio of independence with fibers to 0.080 mm in diameter, and there was a slight increase in density of the dispersion from the last two tracks fiber diameter up to 0.080 mm; and
- statistically, the distribution and training structures organized fibril different diameters in different volumes of the fiber, probably all the fibers is distributed with the same relationship, creating a uniformly structured material.

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