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UNVEILING THE PHYSICAL PROPERTIES OF *CALOTROPIS GIGANTEA* FRUIT-DERIVED FIBER

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Abstract: Calotropis gigantea, a shrub native to Southeast Asia and Africa, produces fruit fibers with unique properties that hold potential for various applications. This study investigates the physical characteristics of Calotropis gigantea fruit fibers collected from Varvada village, Mahesana district, Gujarat. The fibers were tested at ATIRA (Ahmedabad Textile Industry's Research Association) for mean length, breaking strength, breaking extension, and whiteness index. The results show that the fibers have a mean length of 25.91 mm, breaking strength of 4.31 cN, breaking extension of 4.22%, and whiteness index of 5.38%. These properties suggest that Calotropis gigantea fruit fibers have potential applications in the textile, medical, and composite materials sectors. The relatively long fiber length and moderate breaking strength and extension indicate suitability for various uses, while the low whiteness index is common for raw natural fibers due to impurities. The study also reviews the literature on Calotropis gigantea fibers, revealing their high hollowness (80-90%), lack of natural twist, and unique surface morphology. Bark fibers exhibit a tensile strength of 381 MPa, strain at break of 2.1%, and Young's modulus of 9.7 GPa. Further research is needed to optimize the fiber's properties through processing or chemical treatments for specific applications and to address challenges in large-scale cultivation and processing.

IndexTerms – Textile, Calotropis Gigantea, Physical Properties.

INTRODUCTION

The Giant Calotrope (Calotropis Gigantea), a substantial shrub or small tree indigenous to Southeast Asia and parts of Africa, is distinguished by its large leaves and purple and white flowers. Reaching heights of up to 4 meters, it is noted for its rapid growth and adaptability. Although it contains a toxic milky sap that deters herbivores, it has been utilized in traditional medicine. In certain regions, its swift colonization renders it an invasive species. Notably, the plant yields fruit with fibers that are strong, durable, lightweight, moisture-resistant, and thermally insulating. These fibers, which can be extracted through mechanical or chemical methods, hold potential for use in textiles, composites, and packaging due to their resistance to decay and biodegradability. However, the widespread commercial application is impeded by challenges in large-scale cultivation and processing, necessitating further research to optimize extraction and develop competitive applications.

REVIEW OF LITERATURE

Calotropis gigantea fiber exhibits a high degree of hollowness (80-90%) and lacks natural twist (Chen et al., 2013). Its surface morphology and cross-section were studied using scanning electron microscopy, revealing a structure similar to kapok fiber (Chen et al., 2013). The fiber has a crystallinity of 42.54% and a crystallinity orientation index of 85.40% (Chen et al., 2013). Compared to cotton and kapok, C. gigantea fiber has the lowest tenacity but the highest water content (Chen et al., 2013). Interestingly, there are differences between the bark and seed fibers of C. gigantea. The bark fibers are long with thin walls relative to their diameter, making them lightweight (Ashori & Bahreini, 2009). The mechanical properties of the bark fibers include a tensile strength of 381 MPa, strain at break of 2.1%, and Young's modulus of 9.7 GPa (Ashori & Bahreini, 2009). C. gigantea fiber demonstrates unique physical properties that make it a potential candidate for various applications. Its high hollowness and water absorption capabilities, combined with its lightweight nature, suggest potential uses in textile and composite materials. However, its lower tenacity compared to cotton and kapok may limit its application in certain areas requiring high strength (Ashori & Bahreini, 2009; Chen et al., 2013).

METHODOLOGY

Giant calotrope fruit fibers has been collected from varvada village of Mahesana distric, Gujarat. For the application of giant calotrope fruit fiber in industrial sector there is different aspect to study. physical properties of the fiber is one of those aspects. Different aspects of fiber study can help to apply giant calotrope fruit fiber in different sectors like textile, medical, composite

materials, etc. physical testing like length, diameter, moisture regain, breaking strength & breaking extension, whiteness index, microscopic appearance and burning tests has been carried at ATIRA (Ahmedabad Textile Industry's Research Association) for authentic result of the tests.

Sr. No.	Test name	Result	Unit
1.	Mean Length	**25.91**	MM
2.	Breaking strength	**4.31**	CN
3.	Breaking extension	**4.22**	%
5.	Whiteness index	**5.38**	%

Data presents the key physical and mechanical properties of the *Calotropis gigantea* fruit fiber characterized in this study. The 'Test Name' column indicates the specific property measured, with the corresponding 'Result' and 'Unit' provided. For instance, the mean length of the fibers was determined to be 25.91 MM, while the breaking strength was measured at 4.31 cN. The breaking extension, indicating the material's ability to stretch before breaking, was 4.22%.

When analyzing the provided data for *Calotropis gigantea* fruit fiber, the table reveals crucial insights into its physical and mechanical characteristics. The **Mean Length** of 25.91 MM indicates that this fiber is relatively long, a desirable trait for textile applications and for use as a reinforcing material in composites, as longer fibers generally contribute to better strength and integrity.

The **Breaking Strength** of 4.31 CN signifies the force required to break a single fiber. This value, expressed in centinewtons, is a direct measure of the fiber's tenacity and ability to withstand tensile stress before failure.
The **Breaking Extension** of 4.22% represents the percentage by which the fiber stretches before it breaks. This property, also known as elongation at break, is important for determining the fiber's flexibility and resilience. A moderate breaking extension suggests that *Calotropis gigantea* fiber possesses a certain degree of elasticity, preventing it from being overly brittle.
The **Whiteness Index** of 5.38, is typically a measure of the fiber's visual brightness or lightness. A higher whiteness index (100%) often indicates a purer fiber that may require less bleaching or chemical treatment for aesthetic applications, which can be advantageous from an environmental and processing cost perspective. Lower whiteness of raw natural fiber is common because of its impurities.

These parameters demonstrate that *Calotropis gigantea* fruit fiber exhibits promising characteristics for various applications, particularly in areas where natural, sustainable, and relatively strong fibers are desired. The combination of its length, breaking strength, and moderate extension suggests its potential suitability for uses ranging from traditional textiles to novel composite materials. Further research often delves into how these properties can be optimized through processing or chemical treatments to enhance specific performance attributes.

SUMMARY

The study investigates the physical properties of Calotropis gigantea fruit fiber, a natural fiber derived from the giant calotrope plant. The fiber was collected from Varvada village in Mahesana district, Gujarat, and tested at ATIRA for various physical parameters. The results show that the fiber has a mean length of 25.91 mm, breaking strength of 4.31 cN, breaking extension of 4.22%, and whiteness index of 5.38%. These properties indicate that Calotropis gigantea fruit fiber has potential applications in the textile, medical, and composite materials sectors. The relatively long fiber length and moderate breaking strength and extension suggest its suitability for various uses, while the low whiteness index is common for raw natural fibers due to impurities. Further research is needed to optimize the fiber's properties through processing or chemical treatments for specific applications.

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