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Editor's Corner: Sustainable Materials from Natural Fibers – Applications and Future Prospects

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Plant Fibers Overview

Sustainability and eco-friendly green materials replaced synthetic materials following the industrial revolution. The use of cellulose fibers as a clothing material and various products has been a significant part of human history for many centuries [1]. The use of natural fibers, however, has decreased over time as technology has advanced, with synthetic fibers taking its place. In the natural world, synthetic polymers are anthropogenic contaminants detrimental to ecosystems. In a quest to find eco-friendly materials from renewable resources, researchers have focused on cellulose materials, the primary reinforcement component of plants' cell walls [2]. Plant-based bio-materials offer a number of benefits, including the ability to regenerate, and biodegrade, as well as being environmentally friendly; they are suitable alternatives to petroleum-based materials. Petroleum resources are being depleted and associated with environmental problems like global warming have led to a great deal of interest in developing sustainable materials made of cellulose, hemicelluloses, and lignin [3]. These makes up most of the cell wall of lignocellulosic biomass. By reducing fossil fuel consumption and switching to renewable materials will occur a sustainable environment. A growing number of researchers have been working on producing environmental-friendly and high-valued products using green, renewable, and sustainable materials. Several natural fibers can be produced from lignocellulosic biomass instead of petroleum-based polymers. Because of its availability, renewability, lightweight, nanoscale dimension, unique morphology, and unparalleled chemical and physical properties, it has been the subject of a wide array of research efforts for a variety of applications. There are approximately 10 tons of biosynthetic cellulose produced annually on Earth, making it the most abundant organic matter [4].

Fundamentals of Plant Fibers

The natural fibers are determined by their physical and chemical morphology, including cell wall growth, patterns, thickness, dimensions, cross-sectional shapes, and lumen distinctiveness. Moreover, these fibers will generate additional employment opportunities, particularly in rural areas, which will further improve the standard of living of people [5]. Therefore, many countries with lignocellulosic fiber resources have begun conducting research and development in order to make use of these advantages. Agro-bioresources can serve as key components of bio-composites. It is possible to use all the components of a fiber crop for upstream and downstream processing of fibers in packaging, building, automotive, marine, electronics, leisure, and household products. Crops around the world produce trillions of tons of lignocellulosic biomass every year, including cereal straw, corn stalks, cotton, and bagasse. It is estimated that approximately 80 percent of these agricultural residues are burned in the field, contributing to environmental pollution [6]. The residues are only used for animal feed or household fuel in small quantities. The exploration of these affordable agricultural residues as a bioresource for making industrial products, it would

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open up new opportunities to utilize agricultural residues by reducing the need for disposal and environmental degradation caused by pollution, fires, and pests [7]. It would also contribute to the development of rural agricultural-based economics. In order to meet the growing energy demands and environmental concerns, it is essential to develop low-cost, sustainable, and renewable resources. Microbes are unable to directly utilize biomass due to its heterogeneity and crystallinity [8]. To efficiently utilize renewable resources, it is essential to effectively separate constitutive components. Plant-based cellulose fibers can be extracted into nano-fiber, which is thinner than bacteria-based cellulose. Now, researchers have been studying the extraction of nanofibers from wood and other plant fibers extensively [9]. It has been traditionally done before the fibrillation process to remove matrix substances such as hemicellulose and lignin embedded in cellulose nanofibers. The matrix removal process is often skipped when pulps have been bleached. A high-pressure homogenizer, and a grinder was used for mechanically fibrillating plant fibers. In recent years, nanofibers have been prepared by ultrasonic or enzymatic methods [10].

Applications and Future Prospects of Natural Fibers

Among the diverse industries where plant fibers are used are textiles, automobiles, aerospace, construction, geotextiles, papers, packaging, furniture, interior design, bioengineering, healthcare, sports goods, and more. Natural fiber production worldwide has increased because of the wide range of applications. Sustainability and eco-consciousness are key drivers of the future of cellulose fibers. Through hybridization and surface modification techniques, there is an array of research being conducted aimed at improving composites that use natural fiber as reinforcement, in terms of thermal and mechanical performance. Additionally, it has become increasingly popular to isolate cellulose, which has applications across a variety of medical fields. Natural fibers present a promising possibility for a future that is more environmentally friendly in an age where sustainability and green materials are becoming increasingly important. Our eco-conscious world will continue to be shaped by plant fibers as research and innovation unfold.

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