EVALUATION OF AGRICULTURAL RESIDUE-BASED FIBERS FOR USE IN AUTOMOTIVE AND CONSTRUCTION INDUSTRIES

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ABSTRACT

Environmentally friendly composites materials generated from natural resources have been produced in response to the increased environmental impact involved in the manufacture, disposal, and recycling of petroleum-based fiber reinforced polymer matrix composites. Disposal of agricultural-waste crops has recently become a major concern in developing countries. Because agro-waste is readily available, its use in the creation of sustainable composite materials rising, making it a particularly appealing alternative for the construction sector. From the standpoint of recently published research in this sector, the use of agricultural waste and residual materials in composites is both environmentally beneficial and much more valuable. Therefore, this is a complete analysis exploring how agricultural waste and residues may be used as reinforcements or additions for NFPCs in the future. This review paper will serve as a comprehensive data base for future study into the utilization of agricultural waste and residues fiber-reinforced polymer composites as low-cost primary building materials. In the final section, the potential for agro-waste materials to partially take the place of traditional composites in building material research is examined. Water absorption's effect on composite mechanical characteristics is also illustrated. The literature review analyses prior studies' moisture/water content levels to conventional materials in use and the parameters for building and construction materials

Keywords: *Natural fiber; agricultural waste; composites; buildings; moisture absorption*

INTRODUCTION

Agricultural residues and weed plant residues can cater to the growing demand for paper in the packaging sector, as well as hygiene and sanitation products, such as paper towels, toilet paper, and disposable makeup wipes, among others. In India, for instance, agricultural residues account for approximately 28% of the total feedstock used in the pulp and paper industry, supplied mainly from bagasse, wheat and rice straws, and cotton stalks. Describes, overall, the types of raw material and their processing stages in paper formation. It can be seen from that, among the raw materials, forest wood remains the most common raw material. Nonetheless, the paper produced from either of three clusters remains as a fabric material, produced by removing water from a slurry containing cellulosic fibers. The use of forest resources to make pulp has increased in recent years, having a variety of industries, such as furniture manufacturing, construction, and others, using wood as a raw material. The pulp and paper industry relies primarily on the uses of fibrous wood. This overreliance on fibrous wood is linked to significant environmental problems, including deforestation, greenhouse gas emissions, and global warming. These agricultural residues have, then, the potential to replace woody lignocellulosic biomass since they can be sustainable and affordable sources of cellulosic fiber. Their remnants are structurally similar to other plant fibers utilized in production, in terms of composition and physical and chemical characteristics. Agricultural residues, like hemp, jute, kenaf, rice and wheat straw, and sugarcane bagasse, are promising pulp and paper-producing alternatives to woody materials

The concept of environmentally friendly and sustainable development has an impact on manufacturing activities. It is common practice to turn leftover biomass from different plants into natural fibers. According to research, each year, billions of tonnes of stems from banana plants are thrown away. After harvesting the fruit, farmers often burn it or discard it in rivers and lakes, but incorrect disposal may have detrimental ecological repercussions. It is possible to cultivate banana trees without using pesticides or other chemicals. Reducing adverse social and environmental effects, such as the carbon footprints linked to textile manufacturing, is the goal of promoting eco-friendly apparel and textiles. Women from the villages may take part in the production of various bio-products from banana waste, in addition to giving rural communities and hilly areas the chance to enhance their quality of life. The use of functional foods and beverages is rapidly increasing as people's concerns about their health and well-being expand. After learning that coconut meals and beverages include vitamins and nutrients, beverage firms are attempting to boost their market share. Consequently, downstream production has supplanted upstream agriculture in the manufacture of coconut-based goods and beverages. The result is coconut residues. The discarded coconut shells are often used to make char, which may be used as fuel in rural regions or to make activated carbon for industrial uses. However, the primary obstacles to using coconut mesomorphs as fuel are its high potassium and moisture content. Consequently, the coconut mesomorphs is dumped in a landfill after being removed from the production line. This presents a chance for waste up cycling by recovering fibre from leftover coconut mesomorphs. Traditionally, chemical treatment is used to generate natural fibre. It could enhance the fibre material's surface, chemical, and mechanical qualities. However, since chemicals are utilized in this treatment procedure, the environment is in risk. Agricultural waste is cleaned by steam explosion under sub critical water conditions. Its operation is divided into two stages. The product is suddenly discharged to reduce the pressure ("Explosion") after the feed stock has been processed with steam ("Steam") at a certain temperature and pressure. As a result, steam explosion provides effective fibre breakdown. Numerous researchers have examined steam explosions. Orange peel has been converted into nutrient-dense fibre by means of steam explosion and acid soaking. Good product qualities including high water solubility and the capacity to retain both water and oil were achieved by this combined treatment procedure. Fibre could turn out to be a useful component of food products. Wheat straw was transformed into very pure cellulose microfiber with the use of steam explosion.

LITERATURE REVIW

Ana Paula Provin (2024) examines and synthesizes the scientific research on agricultural waste from bananas and its possible use in the textile industry, especially in relation to clothing fibre. The environmental effects of the textile industry and trash from the agro-industry are investigated. Furthermore, with an emphasis on the creation of textile materials, the potential of banana agricultural waste—more specifically, banana fiber—as a way to lessen the effects of both sectors is highlighted. It is emphasized that using agro-industry waste from banana plantations to make textiles is consistent with both the Circular Economy (CE) and the Sustainable Development Goals (SDGs). The study made use of databases including Science-direct, Sc-opus, Web of Science, and Sprinkling as well as secondary sources such articles from the Ellen MacArthur Foundation (EMF). The study's goal of gathering research over the last ten years on the use of banana farm waste in the textile industry—while taking into account the advantages, difficulties, and creative methods to use it in new applications—was accomplished by the 71 papers that make up the final portfolio.

Temidayo, Emmanuel Omoniyi (2023) As previously mentioned, attempts to enhance the quality of natural fibers in order to replace them with fossil fuels and other natural resources have run into problems throughout time. A thorough understanding of their processing, hybridization, and characterization features might lead to their widespread usage in a range of applications. Because of its high strength, cheap cost, renewable nature, and environmental friendliness, banana pseudo stem (BPS) fibre has recently been the subject of intense attempts to find applications in polymer composites, engineering, maritime engineering, architecture, sport, and agriculture. It is possible to hybridize BPS fibre with other natural or synthetic fibers, or sometimes both, to enhance mechanical qualities, decrease water input, and increase heat stability.

T.K. Kunhamu, (2022) Reducing the negative impacts of agricultural intensification, which has historically led to a range of land-use-related problems globally, is the aim of using nature-based solutions (NbS) in farming. Often referred to as "coconut-based food forests," they provide a variety of foods, including fruits, nuts, and tubers. They could also help to boost biodiversity. Another noteworthy aspect of CBFS is its biological carbon sequestration. In addition to meeting a variety of provisioning and cultural demands, diverse crop combinations—particularly those that include tree crops—may enhance carbon sequestration. This study examines the biodiversity outcomes and ecological services provided by CBFS, with a focus on Kerala. It also looks at the organization's activities and the natural resource-related problems it addresses.

Vinay Kumar Patel (2021) In recent years, there has been a notable surge in the demand for robust, lightweight fabrics made from natural fibers. Because natural fibers are more readily available, have a lower density, and are easier to renew, their usage has skyrocketed. Compared to composites constructed of synthetic fibers, natural leaf fibers are more rigid, need less energy, pose fewer health risks, are environmentally benign, and provide superior insulation. The retying procedure also makes it simple to remove them from the plant. Because they are less expensive, have less machining wear, and work well in engineering applications, natural leaf fibre composites are better reinforcing materials than other plant fibers. The mechanical and physical characteristics of many composites made from natural leaf fibre are investigated in this research.

Fibers from Agricultural Wastes

Fibers derived from agricultural waste biomass pertain to fibers procured from the residual components of crops, including but not limited to straw, stalks, leaves, and husks. Composites, nonwoven, and biodegradables can all benefit from the use of these fibers as reinforcement thanks to their easy extraction and processing. The use of fibers derived from agricultural waste biomass has environmental advantages, such as the fact that they are renewable and biodegradable. In addition to fostering a more sustainable future, the use of these fibers can help to reduce dependency on finite resources. Notwithstanding, the utilization of said fibers is accompanied by certain obstacles, including inconsistencies in the caliber and accessibility of the refuse, alongside processing intricacies. However, through additional investigation and advancement, fibers derived from agricultural waste biomass possess the capability to emerge as a prevalent and significant constituent of a sustainable and eco-friendly prospect. Nonwoven materials and biodegradable goods made from a variety of fibers that may be utilized as reinforcement in composite materials are one way that people are making strides towards a greener tomorrow for different types of agricultural wastes).

Utilization Of Agricultural Waste Fibers

Bio-composite materials made from agra have been used for many years in a range of applications. Another creative use for nitrocellulose fibre bio-composites is the development of loose-fill packaging and biomedical applications made from agricultural waste have been utilized in various nations to replace or augment wood in construction components, either alone or in conjunction with other materials. For instance, gasbag fibers have been employed in Indian research on agricultural waste fibre to create improved insulating boards. Gasbag has been used to make particleboard in China. In Thailand, studies on Thai hardwoods and hardwoods derived from coconut fibre have been carried out. Their qualities were either on par with or better than those of Japan.

Natural Fiber Polymer Composites

Natural fibre polymer composites, or NFPCs, are made of high-strength natural fibres, such as flax, kenaf, sisal, oil palm, jute, and others, mixed with a polymer matrix. One or two-dimensional molecules that tend to soften at higher temperatures and return to their original properties when cooled make up thermoplastic matrix materials. In contrast, high cross-linking polymers, or thermoses, cure when heated, compressed, or exposed to light. The remarkable strength, modulus, and flexibility of thermometer polymers allow for the tailoring of desired end properties. Thermoplastics like polyethylene, polypropylene (PP), and polyvinyl chloride (PVC) are typically used to make bio-fibers; epoxy, polyester, and phenol resins are often used to create the somer setting matrices in bio-fibers.

Application of Agriculture Waste for Non-woven Applications.

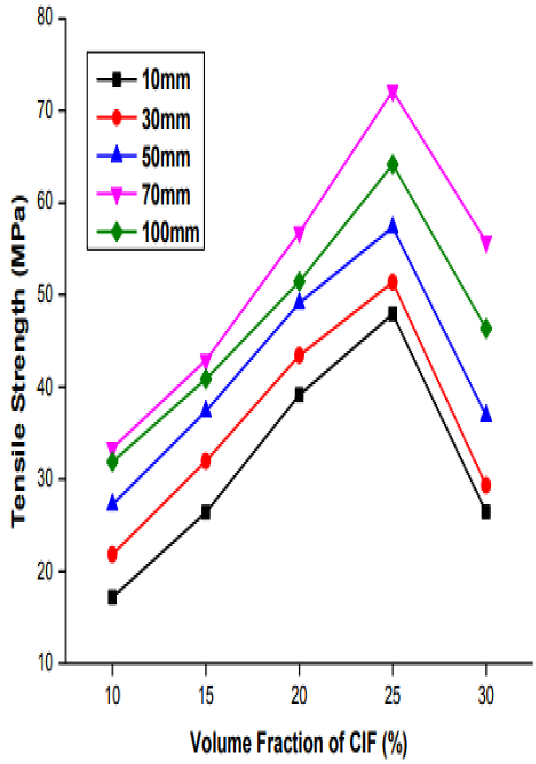
Because there is less heat transmission, less energy may be needed for heating and cooling. Non-woven textiles are a significant class of materials that might meet these requirements; for instance, they provide mechanical strength, low weight, and thermal insulation for particular uses in the automobile and aerospace industries. Therefore, when there is stagnant air within the porous structure, materials are efficiently thermally insulated. Given that less heat is transferred by conduction and radiation, a thicker, fibrous nonwoven fabric may provide better thermal insulation. The fibers of the thicker webs may limit radiation by providing a convoluted path or a lower mean free route, and a larger volume of trapped air inside the webs may inhibit heat transmission. Because lumen s lower fibre density, several studies have shown that fibers with lumen s provide efficient thermal insulation.

METHODOLOGY

The biological behaviour of unsaturated polyester composites supplemented with coconut inflorescence fibre was examined in addition to the testing of their tensile and extramural qualities. Natural fibre reinforced polymer composites are advantageous for biological applications because they are less expensive than natural fillers and are environmentally benign and biodegradable. Despite having a relatively high wear rate, the NFRC's hardness value makes it a good choice for wear applications. In dry sliding conditions, a barometric setup was used to examine the wear and friction coefficient. Cylindrical test tubes are used to create the specimens for the dry sliding wear test. The basic matrix for the specimens, which included different proportions of fibre, was unsaturated polyester resin. Before being reinforced with unsaturated polyester resin, the surface of the coconut inflorescence fibers is alkali treated with a 5% wt/vol NaOH solution. The specimens measure 35 mm in length and 10 mm in diameter in accordance with ASTM G-99 requirements. A pin-on-disc wear test technique was used to analyse the trigonometric behaviour of the previously manufactured coconut fibre reinforced unsaturated polyester composites.

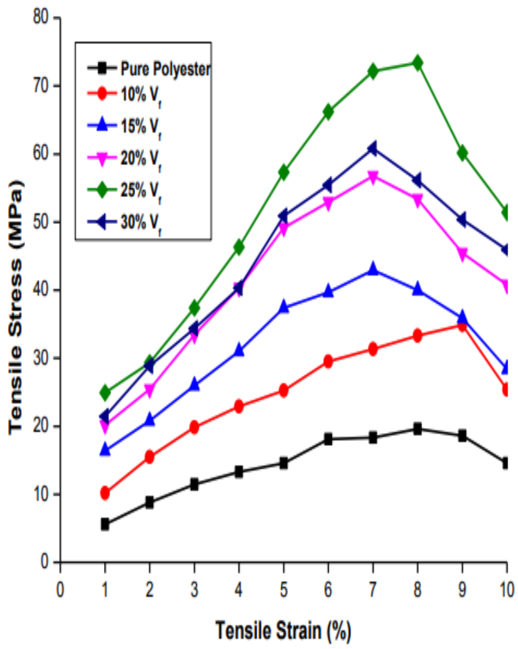
RESULTS AND DISCUSSIONS

Graph 1 displays the change in tensile strength for the larger percentage of fibre volume throughout a variety of fibre reinforcement lengths. The minimum tensile strength for 10 mm fibre with a 10% volume percentage was 17.19 MPa. Tensile strength increased by 15% when the Vf of 70mm fibre length was 25% more than the lowest and maximum values. External fibrillation caused by ratting may completely or partially damage the fiber's primary walls. The fibers also become conformable as a result of internal fibrillation. The findings showed that the fiber-to-matrix stress transfer capacity in composites is impacted by an inadequate matrix.



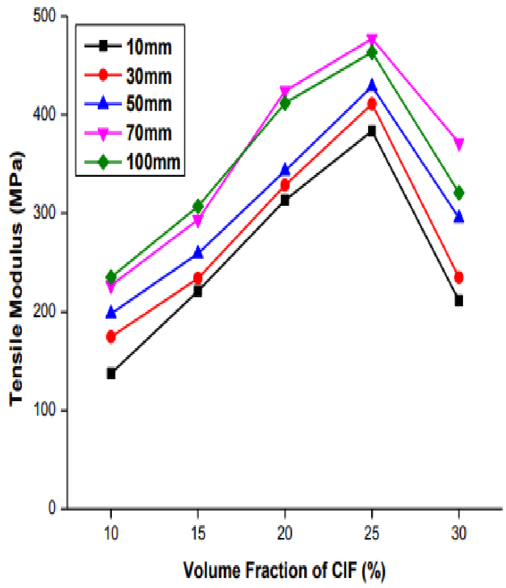
Graph 1 The impact of volume % and fibre length on the tensile strength of CIF

Graph 2 displays the tensile stress strain curve for different fibre volume fractions at 70 mm fibre length. The stress-strain curve for unsaturated polyester resin indicates that the addition of CIF has a ductile rather than brittle effect. The polyester resin shows less elongation at break than the 10% Vf composite samples. The 25% Vf composites aid in reaching the maximum stress value as strain increases. The 25% Vf stress strain curve affects the composites' maximum tensile strength. The Young's modulus of the composite sample was calculated using the elastic character of the stress-strain curve. As the fibre length increases, the stress value decreases because to the intricate structure of the CIF.



Graph 2: Ductile stress and difficulty curve for different fibre amount forcemeat over a 70 mm material dimension

Gradually, the tensile modulus increased to 25% Vf. Consequently, at a fibre length of 100 mm, the maximum tensile modulus decreases to 342 MPa. When the fibre length beyond a certain threshold, the tensile modulus decreases. This suggests that the volume percentage and fibre length have a major impact on the tensile modulus of any natural fibre polymer composite.



Graph 3: Fibre length's effect on the volume % of the CIF's tensile modulus.

The variation in extramural strength across various fibre volume fractions at various fibre lengths is seen in Graph 3. The figure made it evident that extramural strength rose with fibre length as the volume percentage of the composites grew. For a 100 mm fibre length with 25% Vf, the greatest extramural strength was 122.7 MPa, while for a fibre length with 10% Vf, the lowest was 30 MPa.

CONCLUSION

Agricultural residues could be suitable for cellulosic fiber sources in the pulp and paper industry since they are renewable, inexpensive, and abundant. Cotton stalks, rice straws, wheat straws, sugarcane bagasse, and corn stalks are all non-wood plant fibers currently employed as papermaking raw materials by many paper manufacturing companies. The primary goals of the project were to evaluate and isolate composite fibers from agricultural waste, particularly coconut coir and banana pseudo stems, and determine if these fibers might be used in the industrial sector. These characteristics are crucial to materials engineering, particularly for developing eco-friendly composite materials. The results of the experiment show that the relatively higher lignin content of coconut coir fibers makes them more robust and stiff, which makes them ideal for usage in construction panels, car interiors and packaging. Banana fibers are more flexible, nevertheless, due to their finer texture and greater cellulose content, and they may be used as reinforcement in lightweight panels, biodegradable carpets, and textile composites. Traditional pulp bleaching technologies involving chlorine and chlorine compounds are still used, putting an enormous burden on environmental resources. Furthermore, the developed products can be converted to specialized membranes, which can be applied to a wide range of industries, ranging from water purification to medicinal uses.

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