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Sustainable Fabrication of Unmanned Aerial Vehicle (UAV) Blade using Composite PLA and Woven fabric of Date Palm Fiber (DPF)

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Abstract

This study develops a sustainable composite material for UAV blades using woven polylactic acid (PLA) and date palm fiber (DPF). The biodegradable PLA matrix reinforced with DPF provides a lightweight and high-strength alternative to conventional epoxy–glass fiber or carbon fiber composites, while significantly reducing environmental impact. DPF was first extracted and chemically treated to enhance surface adhesion. The fibers, with an average diameter of 220 µm, were spun into yarns and woven into plain-weave fabrics with controlled uniformity. The woven mats were impregnated with PLA, ensuring effective fiber coating, improved moisture resistance, and the formation of prepreg textile sheets and molded to fabricate the UAV blade. The resulting composite exhibited a laminate thickness of 3 mm, suitable for aerodynamic blade design. Mechanical characterization showed tensile strength of 95 MPa and flexural strength of 150 MPa, with a specific modulus competitive with glass fiber composites at a fraction of the weight. Optimized fiber extraction and weaving improved fiber–matrix bonding, while the plain weave configuration ensured stable load distribution under bending stresses.

The proposed PLA/DPF composite demonstrates strong potential for UAV applications by combining structural integrity, weight reduction, and biodegradability. It not only upcycles agricultural waste but also offers a sustainable alternative to petroleum-based composites, enabling lower carbon footprint and end-of-life recyclability.

Keywords
UAV blade, woven fabric PLA/Date Palm Fiber (DPF) composite, additive manufacturing.

Biographies
Abderraouf Gherissi is an Associate Professor of Mechanical Engineering at the University of Tabuk, Saudi Arabia. He obtained his Ph.D. in Mechanical Engineering from the University of Tunis El Manar, Tunisia, in 2014. His professional background includes industrial and academic experience. He served as Head of the Maintenance Department at Graphic Art Diffusion, Tunisia, before moving into academia as a Mechanical and Industrial Instructor at the Industrial Center of Maintenance in Tunis and later at Ruasyl Institute in Muscat, Oman. Since 2015, he has been a faculty member in the Department of Mechanical Engineering at the University of Tabuk, where he was appointed Assistant Professor and subsequently promoted to Associate Professor. His research interests include sustainable materials, advanced manufacturing processes, and renewable energy. His teaching portfolio covers a broad range of courses, including manufacturing processes, engineering materials, solid mechanics, mechanical design, CAD/CAM, statics, dynamics, vibrations, finite element methods, mechanics of machines, mechatronics, production workshops, and both destructive and non-destructive testing laboratories.

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