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Mechanical Properties of Durian/Luffa Fiber Reinforced Polymer Composite

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Abstract. This research explores the development of advanced materials known as natural fiber reinforced polymer (FRP) composites with the aim of enhancing overall quality of life. Hybrid fibers derived from durian/luffa fibers were integrated into Polyethylene (PE) matrices to fabricate hybrid natural fiber PE composites. The study involves a comprehensive examination of these composites through tensile testing, scanning electron microscopy (SEM), and Fourier-Transform Infrared (FTIR) analysis. Results indicate that the tensile strength of the durian/luffa PE (DLPE) composite surpasses that of neat PE laminates, highlighting its superior stress tolerance. Overall, the composites exhibit specific tensile strength and modulus, contributing to the creation of lightweight materials compared to neat PE. SEM analysis indicates satisfactory fiber-to-matrix bonding with room for improvement, as observed gaps between fibers and matrix are present. FTIR analysis uncovers constituents in the chemical composition of durian and luffa fibers. The inclusion of natural fibers as an alternative to synthetic counterparts aligns with Sustainable Development Goals (SDG) standards. This research underscores the feasibility and benefits of fiber hybridization, emphasizing improved mechanical strength, environmental sustainability, and cost efficiency.

Introduction

Integration of reinforcing fillers, such as fibers, within a polymer matrix, synergistic mechanical properties that cannot be achieved by either component alone, results in a multi-phase material called a polymer composite [1] or also known as fiber-reinforced polymer (FRP) composite. Many applications in major fields such as construction, mechanical, automobile, aerospace, biomedical, and marine, utilizes composite polymers with addition of natural or synthetic fibers in its fabrication, as the durability of FRPs are proven to be better than conventional materials alone [2]. Synthetic fibers common in FRPs are usually glass, carbon, or aramid [3], which is not natural nor biodegradable [4], thus possessing a threat to the environment in relation to accumulation of plastic waste [5]. In order to combat this issue, research in alternatives for both matrix and filler, such as natural fibers, biopolymers, and chemical treatments, are constantly being engineered, as the world's non-renewable resources are depleted by the second [6]. The utilization of natural fibers such as coir, jute, bagasse, cotton, bamboo, and hemp [7] exist as lightweight, durable, renewable, cheap, and biodegradable substitutes for synthetic fibers in FRPs. The properties of the hybrid composite may reveal peculiar results in comparison with the individual components of the FRP composites.

Luffa acutangula / Luffa cylindrica. Seen in Figure 1 is luffa and its fiber. Luffa, also known as sponge gourd, is a *Cucurbitaceae* (cucumber) family plant that grows from south Asia through east and central Asia. Its fruit, a gourd, is green and cylindrical in shape, and it climbs on other solid physical surfaces. Its mature fruit is consumed like vegetables, but its immature fruits are used as natural cleaning sponges. Luffa fibers have substantial toughness, strength, and stiffness, like those found in metals of similar density [8]. The chemical makeup of luffa is mostly made up of lignin and hemicellulose/cellulose, but it also contains inorganic components such as glycosides, polypeptides, amino acids, proteins, and other compounds [9].

Durio zibenthinus. Seen in Figure 2 is durian and its fiber. It is a tropical fruit termed as the "King of Fruits" and is popular in southeast Asia. Morphology of durian is armed with sharp thorns on the