Fabrication and Characterization of Novel Mycelium Based Composite Materials

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ABSTRACT

This investigations focuses on characterizing innovative mycelium based composite material. The goal is to create sustainable and biodegradable packaging materials that combat waste accumulation. By comparing *Pleurotus eryngii* and *Ganoderma lucidum*, the study determines their suitability through controlled growth and processing methods. This research explores mycelium's potential across diverse substrates, with *Ganoderma lucidum* demonstrating robust growth and favorable mycelium development. Challenges in the process suggested compression and dimension use.

INTRODUCTION

The demand for delivery packages surged 32% during the Covid-19 pandemic (US Government Accountability Office, 2020), intensifying the production of non-biodegradable materials like plastics and cardboard, causing increased waste. Environmental concerns arise from 82,000 tons of packages, with 30,000 tons in landfills (Environmental Protection Agency, 2018). Non-recyclable materials call for sustainable alternatives. Mycelium, the vegetative part of fungi including *Pleurotus eryngii* and *Ganoderma lucidum*, offers a solution with low-energy growth, minimal byproduct, and cost-effective production using organism remains. Exploring mycelium-based composites to replace packaging aligns with quality and heightened environmental awareness.

OBJECTIVE

The investigation aims to address increased package waste from pandemic-driven online shopping, explore mycelium's potential as eco-friendly packaging, develop mycelium-based composites to reduce waste, understand mycelium's molecular composition for engineering solutions, and contribute to creating sustainable materials that combat pollution.

Figure 1 : Fungus Example

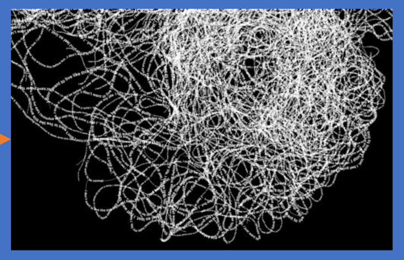

Figure 2 : Mycelium Example

METHODOLOGY

The mycelium has a unique capability in its function that the composites can be modified by controlling the growing conditions and the post growth processing methods to meet a specific mechanical application. The low cost and environmental features are the interests in this study. Two fungi were compared and used in the same procedure to determine which has more sustainability. This is controlling the substrate and the processing method to accomplish the structure desired.

METHODOLOGY (CONT.)

This structure must be a durable, high value composite material. The process to achieve this are the following: Begin to prepare an organic compost with substrate, supplements, soil, and water. The spores of the fungus will be used to reproduce and grow in a controlled environment. Once grown, the fungi spores was used to obtain the mycelium. The hyphal structure will bond forming a fungi skin in a mold made with carton simulating a box. Once formed, it was dried at 70ºC for 5 hours. This drying process is important and crucial since the fungi grows in humidity and retains water. Once completed, the material obtained went through a series of tests to determine if the materials meet the requirements. The density, absorbance and resistance were measured and considered for these requirements.

$$\text{Shrinkage percentage:} \frac{\text{dry percentage} - \text{dry weight}}{\text{wet volume}} \times 100$$

$$\text{Moisture content:} \frac{\text{wet weight} - \text{dry weight}}{\text{dry weight}} \times 100$$

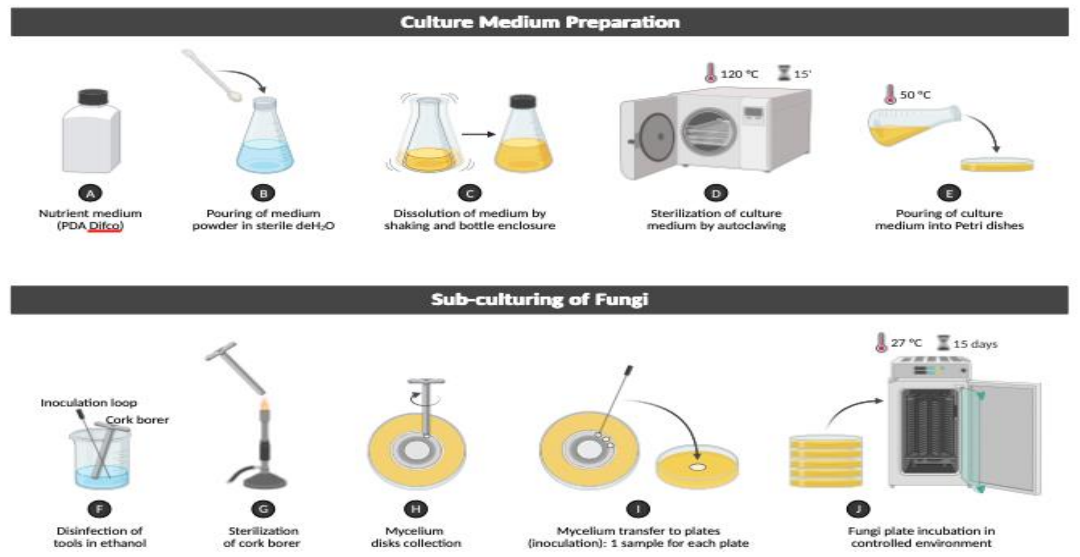

Figure 3: Mycelium Substrate Process

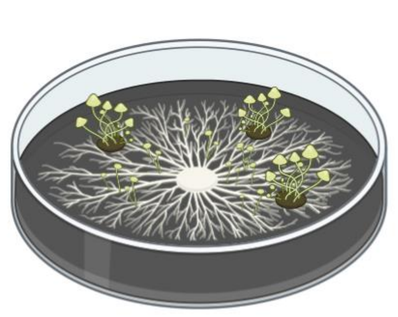

Figure 4: Mycelium grown in Petri Dish

DATA

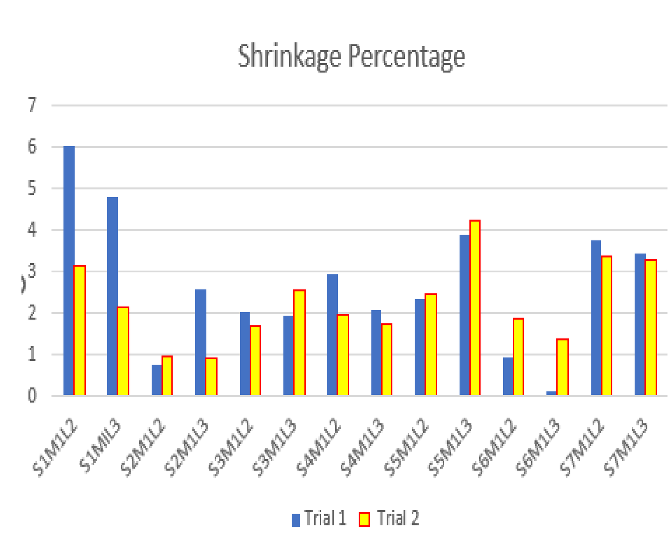

Figure 5: Chart of Shrinkage Percentage

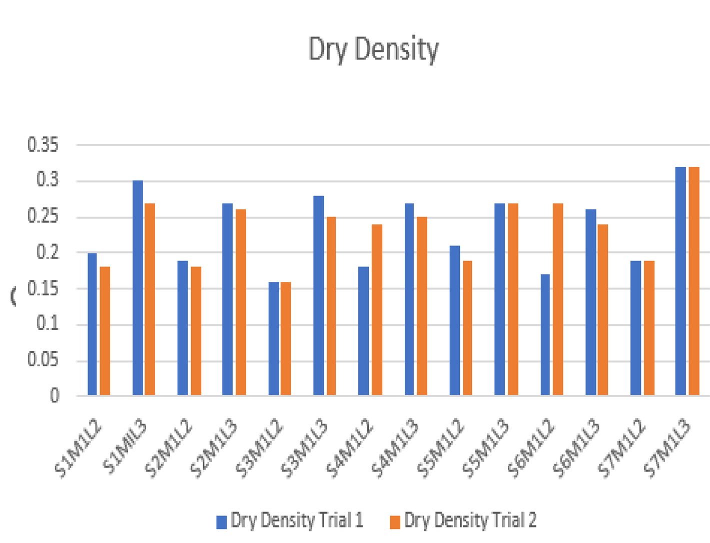

Figure 6: Chart of Dry Density

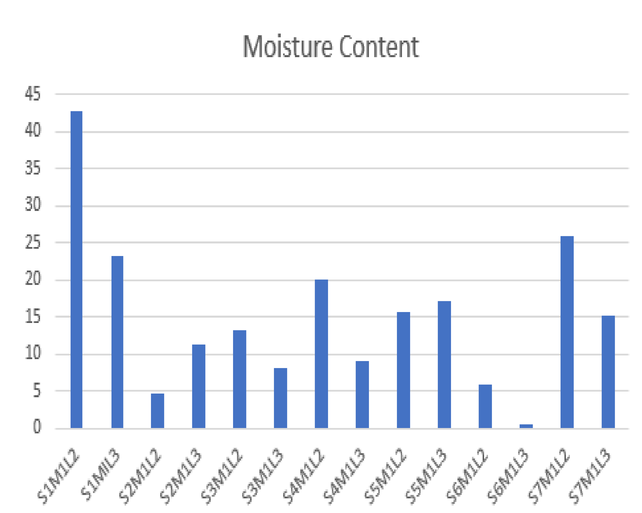

Figure 7: Chart of moisture Content

ANALYSIS & RESULTS

Figure 8: Result 1 of *Ganoderma lucidum*

Figure 9: Result 2 of *Pleurotus eryngii*

ANALYSIS & RESULTS (CONT.)

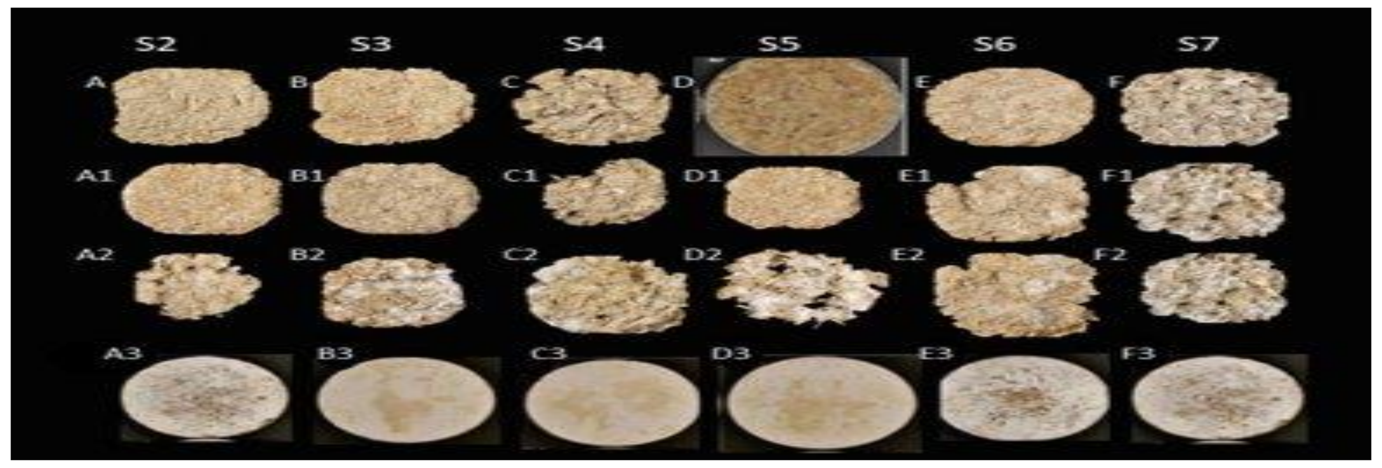

Figure 10: Result of variations of wood and fungi mixtures

Different combinations of *G. lucidum* mycelium bio-composites and substrates were used: pine wood chips (S2), aspen wood chips (S3), cardboard and aspen wood chips (S4), cardboard and pine wood chips (S5), aspen and pine wood chips (S6), and cardboard, aspen, and pine wood chips (S7). Labels A–F represented the substrates before inoculation. Subsequent stages were labeled as follows: A1–F1 for 4-day culture, A2–F2 for 12-day culture demolded without drying, and A3–F3 for dried biocomposites. *Ganoderma lucidum* demonstrated robust growth and substantial mycelium development across various substrates.

CONCLUSION & FUTURE WORK

Ganoderma lucidum mushroom showed fast growth and enhanced mycelium development across substrates. Cardboard stood out for favorable growth, though challenges arose with clumps due to mycelium on cardboard. To address, reevaluating substrate compression is suggested. Refining tablet dimensions is key for fine yet strong products. Future steps include diverse substrates for mycelium growth effects and thorough tests, covering compression, temperature, and water resistance, alongside infrared spectroscopy for mycelium-substrate insights.

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