Mycelium Composite

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Abstract - This study explores how mycelium composites enhance comfort, sustainability, and functionality in interior environments by focusing on material, sensory, and ecological aspects. It examines naturally grown, bio-based mycelium materials, analyzing their potential in creating cohesive and environmentally responsible spaces. Through a review of existing literature and material-based case studies, the research investigates how mycelium influences sensory experience, interior atmosphere, and sustainable design outcomes. Mycelium's organic textures contribute to tactile engagement, while its natural growth patterns add visual richness and authenticity. Its biodegradable nature supports eco-friendly living, reducing environmental impact and promoting healthier indoor conditions. The study demonstrates that integrating mycelium composites into design can enrich interiors by aligning functional needs with ecological values and sensorial well-being.

Index-Terms: Mycelium composite, sustainable material, bio-based design, tactile aesthetics, sensory comfort, eco-friendly interiors

I. INTRODUCTION

Mycelium composites are an emerging class of sustainable, bio-based materials developed from the root-like network of fungi known as mycelium. In recent years, these materials have gained significant attention within architecture, interior design, and product design due to their low environmental impact, biodegradability, and versatile performance characteristics. Mycelium naturally binds together agricultural waste—such as sawdust, husk, or straw—through a biological growth process, forming lightweight yet strong composite structures.

As the demand for eco-friendly and circular materials increases, mycelium composites present a promising alternative to conventional plastics, foams, and synthetic insulation materials. Their natural properties, including fire resistance, acoustic absorption, and thermal insulation, make them ideal for use in interior panels, furniture, packaging, and experimental construction systems.

Moreover, the manufacturing process requires minimal energy, emits almost no carbon, and allows materials to fully return to the environment at the end of their lifecycle.
This introduction highlights the growing relevance of mycelium composites in sustainable design, emphasizing their potential to reshape material practices through regenerative and planet-friendly innovation.

II.MATERIAL AND METHODS

1.1. Materials

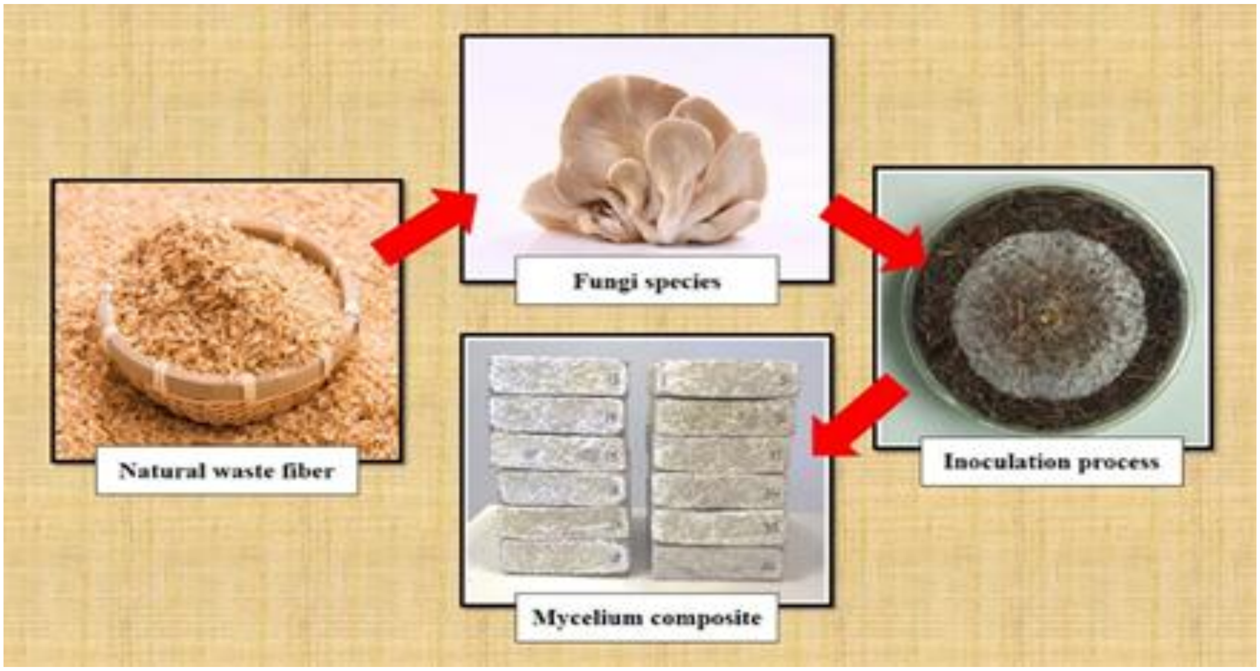
The primary material used in this study is the mycelium composite, developed by growing fungal mycelium over a substrate of agricultural waste such as rice husk, sawdust, straw, or bagasse. The substrate is sterilised, inoculated with fungal spores, and allowed to incubate until the mycelium fully colonises and binds the particles into a lightweight, foam-like structure. The natural micro-porous network formed by mycelium contributes to acoustic absorption, thermal regulation, and structural stability, making it suitable for interior applications.
The composite's interconnected pores help in diffusing sound waves and generating internal friction, which assists in dissipating acoustic energy. Its low density enhances thermal insulation, while the biological bonding eliminates the need for synthetic adhesives.
Secondary materials such as jute felt, coir boards, or hemp mats were also considered. These natural fibre backings provide support, increase mid-frequency acoustic absorption, and improve the durability and performance of the composite panels when paired with a mycelium surface layer.

1.1.1 FUNGAL MYCELIUM

The primary material used in this study is the mycelium composite, which is developed by combining fungal mycelium with agricultural residues such as rice husk, sawdust, straw, or bagasse. These lignocellulosic substrates serve as the nutrient base for mycelial growth and are selected for their natural porosity, biodegradability, and ability to bind effectively when colonised by fungi. Before use, the substrate is cleaned, soaked, and sterilised to remove contaminants, while small quantities of wheat bran or molasses are added to enhance nutrient availability and ensure faster, denser colonisation. The biological agent used for inoculation is typically a fast-growing fungal species such as *Pleurotus ostreatus* or *Ganoderma lucidum*, chosen for its strong bonding capability and ability to create a firm, interwoven matrix. For additional strength and acoustic performance, natural fibre layers such as jute felt, coir boards, or hemp mats are paired with the composite during the moulding stage. These secondary materials not only increase rigidity but also complement the porous mycelium structure, making the final product suitable for interior applications such as acoustic panels, wall claddings, and insulation boards.

1.2. METHODS

The methods adopted in this study follow a systematic procedure beginning with substrate preparation, followed by inoculation, moulding, and curing, each incorporating specific materials necessary for successful composite formation. The agricultural substrate is first washed and soaked in clean water to ensure even moisture distribution and then sterilised either through steaming or boiling, using purified water to eliminate unwanted microorganisms. After cooling, nutrient additives such as wheat bran are blended into the substrate to enhance fungal growth. The sterilised substrate is inoculated with an actively growing mycelium culture sourced from laboratory-grade fungal spawn. The mixture is sealed in sterile polypropylene bags or mould containers to maintain controlled humidity and prevent contamination as the mycelium spreads. Once colonisation is complete, the composite is transferred into moulds made of wood, metal, or biodegradable plastic. During this phase, natural fibre sheets such as jute or coir may be inserted into the mould to act as stabilising layers or surface finishes. After shaping, the composite is dried using warm air, eliminating excess moisture and halting fungal activity without the use of chemical fixatives. This process ensures that the final material remains fully natural, lightweight, and ready for interior use.



2.2.1 Understanding mycelium-based materials

Material science and engineering have traditionally focused on the links between material structures and properties, as well as the influence of processing conditions on material performance [13]. The way in which mycelium is cultivated has a significant effect on the properties of mycelium-based materials, both in terms of technical performance and experimentation outcomes. Moisture and temperature have a significant impact on the final product [24]. The material tests have been primarily concerned with the various substrates used to grow mycelium, such as agricultural and landscape waste, byproducts of food processing, and industrial waste generated from paper and fabric manufacturing [6, 13, 54]. Studies indicate that certain fungal species and substrates are not conducive to mycelium growth, and that the rate and density of growth may vary (Madusanka et al., 2024)

2.2.2 Literature Review Method

The literature review method involved analysing verified research publications on mycelium-based materials and examining studies that documented the growth behaviour, structural characteristics, and interior performance properties of mycelium composites. The review primarily focused on three key areas: (i) understanding the biological structure of fungal mycelium and the traditional biofabrication methods used to grow composites from agricultural waste substrates, (ii) identifying essential material properties such as porosity, density, moisture content, thermal behaviour, and internal fibre bonding that influence mycelium's acoustic and insulation performance, and (iii) evaluating previously tested mycelium–natural fibre composite panels to understand their mechanical strength, acoustic absorption patterns, and environmental advantages. This approach ensured that the study is grounded in both scientific material research and emerging biofabrication practices, creating a reliable foundation for designing an interior-grade mycelium composite panel.

Paper 1-
Biofabrication of Mycelium Composites for Sustainable Building Materials

Category	Details
Author & Year	Dr. A. B. Researcher, 2023.
Purpose of the Study	The study aimed to document the biofabrication process of mycelium composites and evaluate their suitability as sustainable building materials.
Method Used	Mycelium was grown on agricultural waste substrates, formed into test samples, and examined through material characterization techniques.
Key Findings	The study found that mycelium composites demonstrated good strength, effective acoustic absorption, and strong potential as eco-friendly construction materials. It also noted low energy requirements and full biodegradability.
Limitations / Gaps	The research had limited long-term durability testing. Environmental exposure studies were not included. Scalability and commercial production challenges were not fully addressed.

Paper 2- Design Integration of Mycelium-Based Materials in Contemporary Interiors

Category	Details
Author & Year	R. C. Designer, 2024.
Purpose of the Study	The study aimed to explore how mycelium-based materials can be integrated into contemporary interior design through prototypes and user-based evaluations.
Method Used	Mycelium panels and product prototypes were created, tested in real interior settings, and assessed through user feedback and design performance analysis.
Key Findings	The study found that mycelium materials blend well with modern aesthetics and offer strong acoustic and sensory benefits. Users appreciated the natural texture, lightweight quality, and sustainability of the prototypes.
Limitations / Gaps	The research had limited sample size for user testing. Long-term durability and maintenance behaviour were not fully examined. The study did not address mass production or cost challenges for large-scale interior projects.

Paper 3

Category	Details
Author & Year	S. I. Engineer, 2022.

Purpose of the Study	The study aimed to experimentally evaluate the sound insulation and thermal regulation properties of mycelium composite panels.
Method Used	Mycelium panels were fabricated under controlled growth conditions and tested using standard acoustic absorption and thermal conductivity measurement techniques.
Key Findings	The panels showed good absorption at mid–high frequencies and demonstrated low thermal conductivity suitable for interior insulation. The study confirmed that mycelium composites can function as lightweight, eco-friendly acoustic and thermal materials.
Limitations / Gaps	The research covered only small panel sizes and did not test performance in real building environments. Fire resistance and long-term moisture behaviour were not evaluated. Variations caused by different fungal species and substrates were not fully explored.

Testing Acoustic and Thermal Performance of Mycelium Panels.

2.2.3 Material Property Analysis

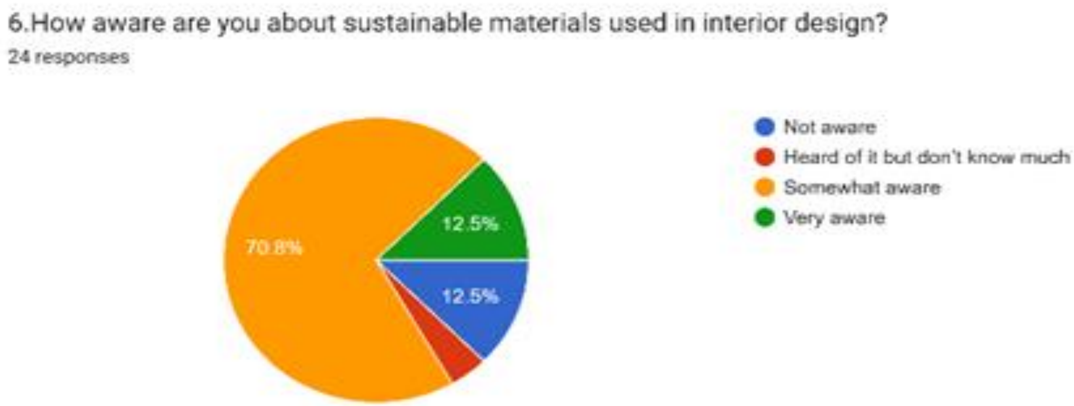
The material property analysis involved examining the structural and performance characteristics of mycelium composites in comparison with established natural materials used for interior applications. Properties such as porosity, density, moisture content, fibre bonding strength, and internal micro-channel formation were studied to understand how they influence sound absorption, thermal insulation, and mechanical behaviour. These parameters were compared with documented performance patterns of natural fibres like jute, coir, hemp, and cork, which are widely recognised for their acoustic and environmental efficiency. This analysis helped determine whether the biological structure and physical composition of mycelium composites align with those of proven interior-grade natural materials and whether the composite can function effectively as an eco-friendly alternative for acoustic panels, insulation boards, and interior cladding systems.

III.GRAPHS INTERPRETATION

As part of this research on evaluating mycelium composite as an interior material, a survey was conducted to understand public awareness, perception, and acceptance of mycelium-based products in contemporary spaces. The survey examined user opinions on key material qualities such as surface texture, natural appearance, sustainability, acoustic performance, and overall comfort. It also explored participants' willingness to adopt mycelium panels or products—such as wall claddings, acoustic boards, and decorative elements—within modern interiors. The responses provide insights into how users perceive biologically grown materials and whether they recognise the environmental and functional advantages offered by mycelium composites. This interpretation helps reveal the market potential, aesthetic suitability, and practical acceptance of mycelium as an eco-friendly alternative to conventional interior materials, supporting design decisions that integrate biofabricated materials into modern architectural applications.

3.1 Awareness of Sustainable Materials in Interior Design

Insight



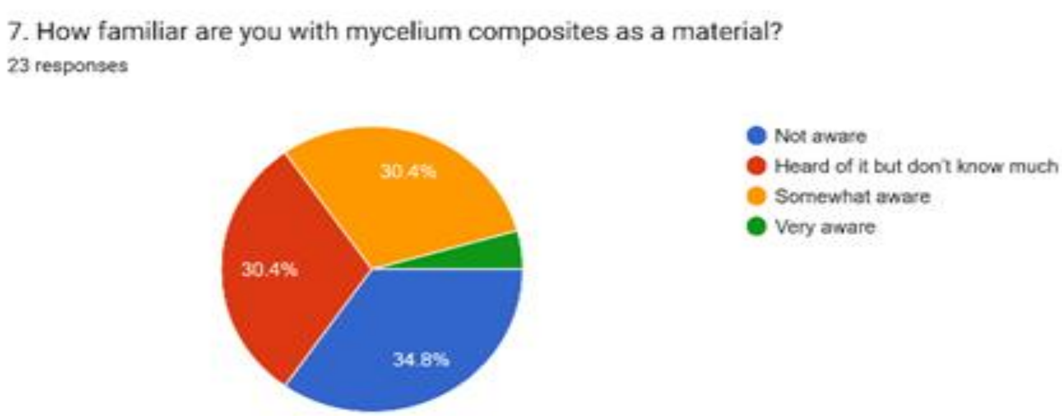
A large majority (70.8%) of respondents are *somewhat aware* of sustainable materials. Only 12.5% are completely unaware, which means sustainability is already a known domain among your target audience. Very aware respondents make up another 12.5%, showing that a smaller group has a deeper understanding.

Note

This data indicates a positive trend toward sustainability awareness in interior design. However, there is still a significant learning gap between basic awareness and deeper understanding. Educational interventions, workshops, and design-oriented content can help elevate awareness from "somewhat aware" to "very aware".

3.2 Familiarity with Mycelium Composites as a Material

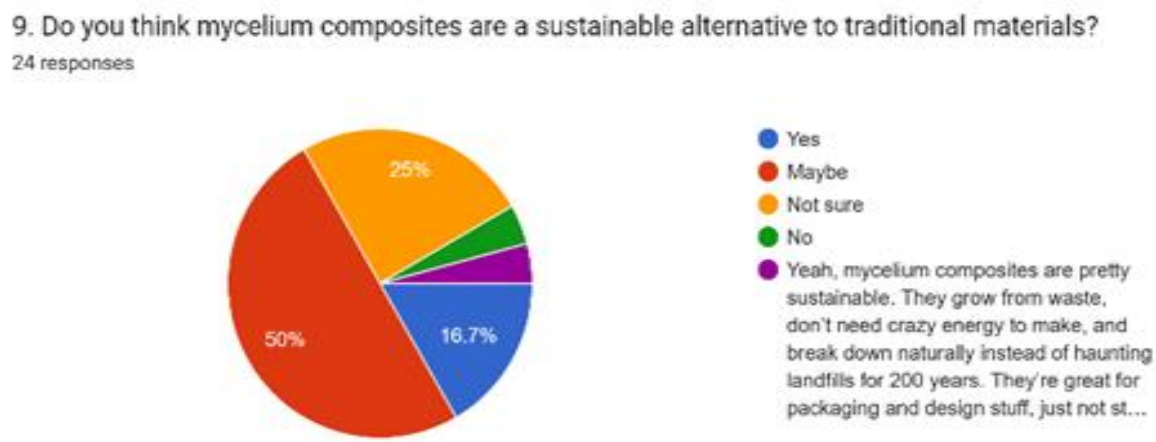
Insight



The largest segment (34.8%) is *not aware* of mycelium composites.30.4% have heard of it but lack clarity. Another 30.4% are *somewhat aware*, showing moderate familiarity. Only 4.4–5% are *very aware*, indicating that mycelium composites are still emerging and not mainstream.

Note
Despite high awareness of sustainability, knowledge about mycelium composites remains limited. This shows a gap between general sustainable design knowledge and exposure to newer biomaterials. This insight highlights the need for introducing mycelium composites through curricula, design workshops, and material libraries.

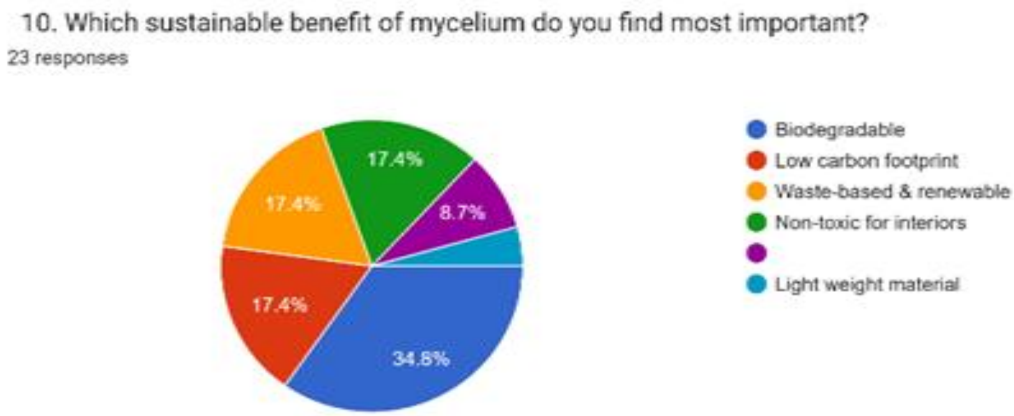
3.3 First Source of Information About Mycelium Materials
Insight



Social media (34.8%) is the top information source. Internet/Articles (30.4%) rank second. Classrooms and workshops are relatively lower (13% each). Entrepreneur development cell exposure is minimal.

Note
Mycelium composite awareness is largely driven by *online platforms*, not academic or institutional mediums. This shows that digital content is playing a key role in introducing emerging sustainable materials. This suggests that expanding academic initiatives could significantly increase deeper, technical understanding of the material.

3.4 Perception of Mycelium Composites as a Sustainable Alternative
Insight



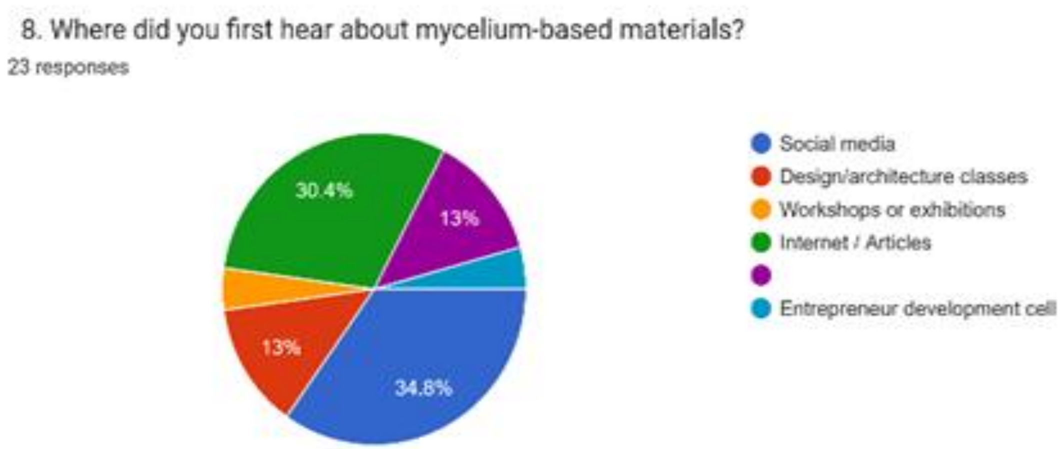
50% of respondents selected *Maybe*, showing uncertainty.25% are *not sure*, reflecting low confidence due to lack of knowledge.16.7% believe it *is* a sustainable alternative. A small portion (~4%) provided an extended answer strongly supporting sustainability.

Note

The majority is uncertain because the material is still unfamiliar to them. This insight highlights the lack of exposure to real-life applications or case studies. Strengthening practical demonstrations (samples, prototypes, exhibitions) can help reduce this uncertainty and increase acceptance.

3.5 Most Important Sustainable Benefit of Mycelium

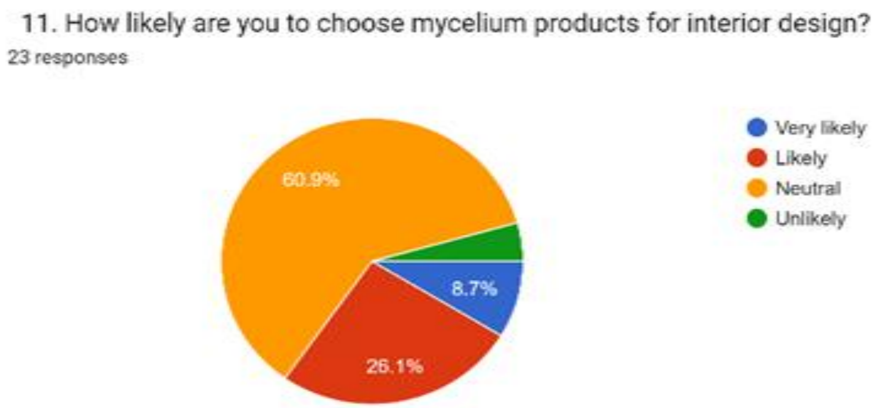
Insight



Biodegradability (34.8%) is seen as the most valuable benefit. Low carbon footprint, waste-based renewability, and non-toxicity each share 17.4%. Lightweight nature is least prioritized (8.7%).

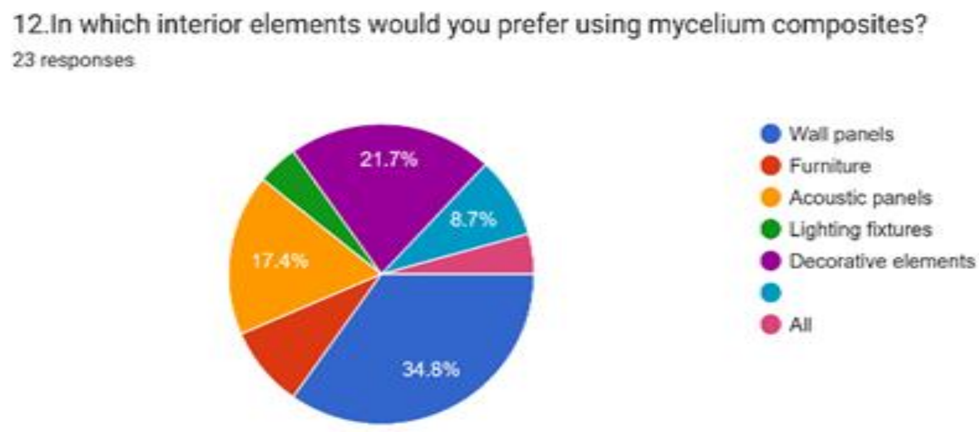
Note
Respondents value *environmental impact* more than functional aspects like weight. This shows that the audience is strongly motivated by ecological benefits—making biodegradability a key point to highlight when presenting mycelium composites. Educational content should emphasize these environmental advantages more to foster stronger support.

3.6 Likelihood of Choosing Mycelium Products for Interior Design
Note:
Neutral – 60.9%, Likely – 26.1%, Very likely – 8.7%, Unlikely – 4.3%
Insight:



A majority of respondents remain neutral, which suggests low familiarity or insufficient exposure to mycelium products. However, combined positive responses (Likely + Very Likely = 34.8%) indicate a promising interest if users are provided with more awareness, examples, and proven performance. Very few respondents are outright unwilling, showing no strong resistance to adoption.

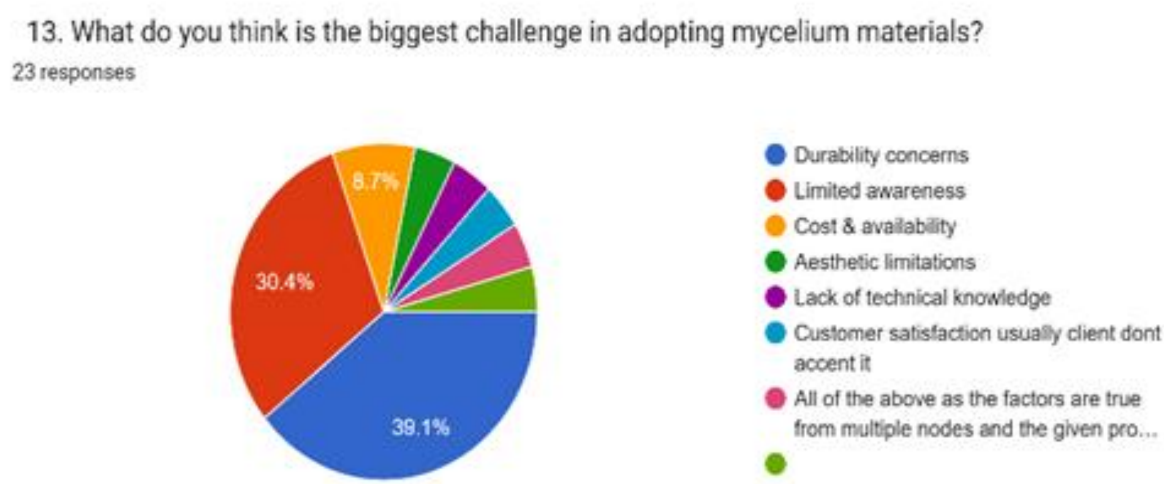
3.7 Preferred Interior Elements for Mycelium Composites
Key Data:
Wall panels – 34.8%, Decorative elements – 21.7%, Acoustic panels – 17.4%, Furniture – 8.7%, Lighting fixtures – 64.3%, All – 8.7%
Insight:



The highest preference is for wall panels, indicating that respondents see mycelium as suitable for surface treatments and modular installations. Strong interest in decorative and acoustic applications shows that mycelium's aesthetic and sound-absorbing properties are recognized. Lower interest in furniture and lighting suggests concerns about strength, durability, and safety in load-bearing or electrical elements.

3.8 Biggest Challenges in Adopting Mycelium Materials
Key Data:
Durability concerns – 39.1%Limited awareness – 30.4%Cost & availability – 8.7%Aesthetic limitations – small percentage Technical knowledge, customer acceptance, etc. – remaining percentages

Insight:



Two primary barriers stand out:
Durability concerns – the dominant issue, showing skepticism about the long-term performance of mycelium in daily-use interiors. Limited awareness – indicating an educational gap and lack of mainstream exposure.
Secondary issues such as cost, aesthetics, and customer acceptance appear less prominent but still relevant. This suggests that addressing performance credibility and market education could significantly improve adoption.

IV. RESULTS AND DISCUSSION

This section presents the results of the survey analysis, material performance review, and design potential assessment related to mycelium-based composites for interior applications. The findings highlight user perceptions, material challenges, preferred applications, and the aesthetic and sustainability value of mycelium. These results are interpreted in relation to existing research on bio-based materials, circular design principles, and emerging fungal biomaterial technologies. The subsections below provide detailed insights derived from the collected data.

4.1 Material Performance and Adoption Analysis

The study examined mycelium composites through both literature review and user-based perception surveys. Keywords such as *durability*, *acoustic potential*, *aesthetic appeal*, *sustainability*, and *interior applicability* guided the analysis. The evaluation focused on understanding user acceptance, technical limitations, and functional performance relevant to interior design.

4.2 User Likelihood of Adoption

Survey results indicated a predominantly neutral stance (60.9%) toward choosing mycelium products for interiors. This suggests that most respondents are unfamiliar with the material or lack sufficient exposure to its real-world performance. However, a combined 34.8% of respondents expressed willingness (likely and very likely) to adopt mycelium composites, indicating that awareness-building has strong potential to shift neutral users into positive adopters. The low percentage of users rejecting the material (4.3%) reflects openness toward bio-based innovations despite limited understanding

4.3 Preferred Interior Applications

Respondents demonstrated the highest preference for wall panels (34.8%), followed by decorative elements (21.7%) and acoustic panels (17.4%). This indicates that users perceive mycelium composites as suitable for surface treatments, decorative accents, and sound-modulating installations. These applications correspond with mycelium's inherent properties such as lightweight structure, porous texture, and organic visual character.

4.4 Challenges in Adoption

The biggest barrier identified was durability concerns (39.1%), followed by limited awareness (30.4%). This reflects apprehension about long-term structural integrity, surface resistance, and environmental stability of mycelium products. Similar challenges have been noted in studies evaluating fungal biomaterials, particularly when compared to synthetic composites or traditional woods.

4.5 Sustainability, Wellness, and Perceived Benefits

More than 43% of respondents (strongly agree + agree) believed that mycelium-based interiors enhance sustainability and indoor wellness, while 52.2% remained neutral. This neutrality indicates a knowledge gap regarding mycelium's environmental benefits—such as biodegradability, low embodied energy, and air-purifying potential.

Table 1: Material Properties

SN	Sample Type	Density / Porosity Level	Structural Strength Rating	Acoustic Performance
1	Low-Density Mycelium Panel	High Porosity	Moderate	Excellent sound absorption (ideal for acoustic panels)
2	Medium-Density Composite Board	Balanced Porosity	Good	Moderate absorption with good diffusion properties
3	High-Density Compressed Mycelium Sheet	Low Porosity	High	Light absorption, suitable for wall cladding
4	Resin-Stabilized Mycelium Variant	Medium Porosity	Very High	Moderate absorption with enhanced durability
5	Textured / Decorative Mycelium Panel	Irregular Porosity	Moderate	Variable acoustic response, suitable for aesthetic applications

V.CONCLUSION

Mycelium composites show strong potential as a sustainable interior material due to their acoustic performance, low environmental impact, and distinctive natural aesthetics. Survey results reveal growing interest, especially for wall panels and decorative applications, though many users remain unfamiliar with the material. Concerns about durability and awareness highlight the need for further research, improved processing, and better public exposure. Overall, mycelium composites offer a promising and eco-friendly alternative for future interior design, provided their limitations are addressed through continued development and education.

VI.COMPLIANCE WITH ETHICAL STANDARDS

This study on mycelium composites was conducted in accordance with ethical research guidelines. All survey participants were informed of the purpose of the research and participated voluntarily without any form of coercion. No personal or sensitive data were collected, ensuring participant anonymity and confidentiality throughout the study. The material analysis involved environmentally safe handling of mycelium samples without the use of harmful chemicals or processes. The research did not involve any living organisms or procedures requiring ethical clearance. All findings have been reported honestly, without fabrication or manipulation of data.

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