International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Fungi as Sound Absorbers

D. Santhi Krupa[1], Pagalla Bhavani Shankar[2], Jeevigunta Naveena Lavanya Latha[3]

[1]Krishna University College of Pharmaceutical Sciences and Research
[2]Krishna University College of Engineering and Technology
[3]Department of Biosciences and Biotechnology, Krishna University, Machilipatnam

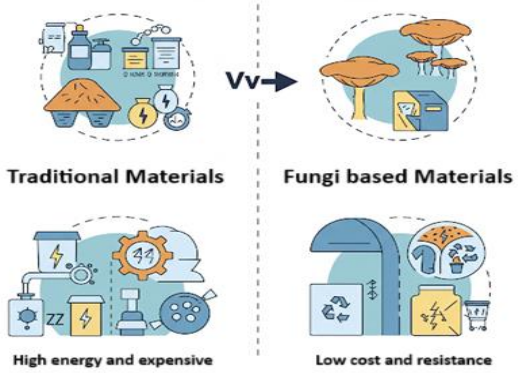
Abstract
Fungal-based material components have emerged as a sustainable sound absorber in the recent years. The composition and structural properties of fungi, particularly their porous mycelium networks, make them highly effective in absorbing sound across various frequencies. As industries seek eco-friendly solutions, fungi-derived sound absorbers have received special attention due to their biodegradability, low cost and high acoustic efficiency. This review explores the structural advantages of fungal materials, their manufacturing techniques and their current applications in fields like architecture, automotive, and environmental management. Additionally, the potential to optimize these materials for enhanced performance through bioengineering is gaining focus of many researchers. Hence, the study highlights the environmental benefits and challenges of implementing fungi-based sound absorbers on a larger scale, aiming to guide future innovations in sustainable acoustic solutions.

Keyword: fungi, sound absorber, mycelium networks

1. Introduction

Sound pollution is growing as harmful concern in urban environments, leading to adverse effects on human health and productivity. Traditional sound absorbing materials such as fiberglass and foam are effective but come with significant environmental costs due to their synthetic nature and limited biodegradability (Jankowski et al., 2020). Sound pollution has become 3rd significant issue in addition to air pollution and water pollution, with impact on hearing loss and sleep disturbances which leads to severe health issues like CVD and mental health.

Figure 1: Comparison of Environmental Impact of Traditional vs. Fungi-Based Sound Absorbers



Noise from traffic and industries in urban areas is the major source of sound pollution As the demand for sustainable alternatives rises, biomaterials like fungi-derived sound absorbers offer a promising solution. Socialized civilization and advanced technology discoveries also lead to enhance the noise pollution with loud music etc. Another major factor contributing to sound pollution is Rail sounds. The Central Pollution Control Board (CPCB) monitors the standards and noise levels to ensure compliance with proper regulations. State PCBs act in coordination with CPCB by enforcing the sound pollution regulations of their states.
Traditional sound absorbing materials viz., fiberglass and foam were being used as synthetic acoustic panels. Fungi, particularly their mycelium networks, which exhibit a unique porous structure that can dissipate sound energy effectively. Mycelium, the vegetative part of fungi, is composed of chitin and glucans, providing both strength and flexibility (Jones et al., 2021). These properties, combined with the ability to grow fungi on agricultural waste, make them an eco-friendly choice for acoustic applications. This review discusses the manufacturing techniques, advantages as promising bio-acoustic material and current applications of fungi-based sound absorbers, highlighting their potential as a sustainable innovation in noise management.'

2. Fungal Species in Sound Absorption Studies

1. **Ganoderma lucidum** commonly known as Reishi Mushroom with limited distribution in Europe and China, is unique for its pharmaceutical activity rather than for nutrition. It was well known for its dense and interconnected mycelium network, making it highly effective in sound absorption and also for its strength and durability, which enhance the structural integrity of acoustic panels.
2. **Pleurotus ostreatus** commonly known as Oyster Mushroom popular edible mushroom which is being cultivated world having nutritional value and potential medicinal properties with antioxidant, antimicrobial, anti-inflammatory, antitumor and immunomodulatory effects. It is one of the most commonly used fungi for bio-composite materials due to its fast growth and adaptability to various substrates. Its mycelium is lightweight and has excellent acoustic properties.
3. **Trametes versicolor** commonly known as Turkey Tail is known for its efficient mycelial growth and ability to form compact, resilient structures. It is commonly used for both sound absorption and thermal insulation applications.
4. **Fomes fomentarius** commonly known as **Tinder Fungus,** produces a dense mycelial structure, offering good acoustic absorption at low frequencies. It is often used in studies focusing on bio-composites for building materials.
5. **Schizophyllum commune** is known for its thin, filamentous mycelium, which contributes to creating porous structures. It was used in experimental studies on biodegradable and sustainable sound-absorbing panels.
6. **Lentinula edodes** commonly known as **Shiitake Mushroom is p**opular for its strong and flexible mycelial structure, suitable for acoustic panel production. Its growth on agricultural waste makes it an eco-friendly choice.
7. **Aspergillus niger,** an ascomycete fungus, producing a sheathy dense mycelium is used for experimental sound absorption studies, often combined with other materials for enhanced properties.
8. **Cladosporium spp. Is u**sed in creating bio-composites due to its ability to grow on various substrates and form porous structures.

9. **Rhizopus oryzae:,** which is known for its fast growth and ability to create fibrous networks, contributing to the acoustic performance of the material.
10. **Hypsizygus ulmarius** commonly known as Elm Oyster is used for its uniform and compact mycelium structure, making it ideal for producing sound-absorbing materials.

Table 1: Fungal Species and Their Potential for Sound Absorption

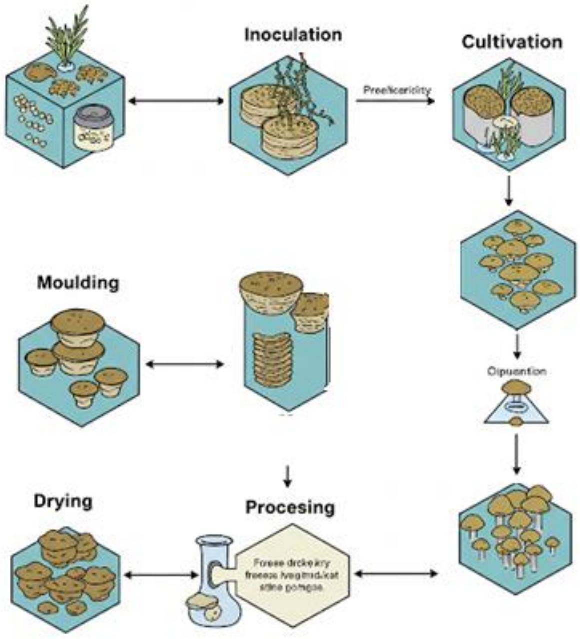
S.No	Fungal Species	Common Name	Key Characteristics for Sound Absorption	Potential Applications
1	*Ganoderma lucidum*	Reishi Mushroom	Dense, interconnected mycelium, strength, durability	Acoustic panels
2	*Pleurotus ostreatus*	Oyster Mushroom	Fast growth, adaptability, lightweight, excellent acoustic properties	Bio-composite materials, acoustic panels
3	*Trametes versicolor*	Turkey Tail	Efficient growth, compact, resilient structure	Sound absorption and thermal insulation
4	*Fomes fomentarius*	Tinder Fungus	Dense mycelial structure, good low-frequency absorption	Bio-composites for building materials
5	*Schizophyllum commune*	Split Gill Fungus	Thin, filamentous mycelium, porous structures	Biodegradable sound-absorbing panels
6	*Lentinula edodes*	Shiitake Mushroom	Strong, flexible mycelial structure, grows on agricultural waste	Acoustic panel production
7	*Aspergillus niger*	Black Mold	Sheathy dense mycelium, often used in composites	Experimental sound absorption studies
8	*Cladosporium spp.*	Cladosporium	Grows on various substrates, forms porous structures	Bio-composites
9	*Rhizopus oryzae*	Rhizopus	Fast growth, fibrous networks	Acoustic performance of the material
10	*Hypsizygus ulmarius*	Elm Oyster	Uniform, compact mycelium structure	Sound-absorbing materials

Many of the above fungi grow rapidly, reducing production time for mycelium-based materials. Their ability to thrive on diverse agricultural by-products and waste materials make them a good choice. The porous and fibrous nature of their mycelium networks is ideal for sound absorption. These species contribute to environmentally friendly production processes due to their biodegradable nature.
These fungal species are integral to the development of innovative and sustainable acoustic solutions, contributing significantly to the fields of green building and environmental noise control.

3. Production of fungal sound absorbers

The production of fungi-based sound absorbers involves cultivating mycelium and integrating it with other natural or synthetic materials for enhanced performance. The important steps include: Substrate identification and preparation, cultivation, moulding and shaping and processing to enhance the working ability. Substrate may be agricultural by-products like straw, sawdust, or husks are sterilized and used as growth mediums for fungi (Holt et al., 2018). Cultivation can be done by inoculating spores onto the substrate under controlled humidity and temperature conditions to promote mycelium growth. The mycelium-substrate mixture thus placed into molds to achieve desired shapes and required thicknesses for acoustic panels or tiles (Islam et al., 2020). Later, the grown mycelium is dried to halt further fungal activity and ensure durability. Surface treatments or impregnation with natural oils and resins can improve water resistance and longevity without compromising acoustic properties (Ali et al., 2019).

Figure 2: Schematic Representation of Fungi-Based Sound Absorber Production Process



3. Advantages of Fungi-Based Sound Absorbers

- Fungi being biodegradable, renewable, and can be grown on versatile media types using waste materials, reducing environmental impact (Jones et al., 2021).
- Production costs are relatively low due to the use of inexpensive substrates and simple cultivation methods.
- The porous structure of mycelium due to their intervening hypha effectively absorbs sound across a wide range of frequencies (Holt et al., 2018).
- Fungi-based panels are lightweight, foldable and can be customized in shape and size for various applications.
- Unlike synthetic alternatives, fungi-derived materials are free from harmful chemicals through proper care during cultivation, making them safer for indoor use.

Table 2: Comparison of Fungi-Based vs. Traditional Sound Absorbing Materials

S. No	Feature	Fungi-Based Sound Absorbers	Traditional Synthetic Materials (e.g., Fiberglass, Foam)
1	Source	Renewable, Biodegradable	Non-renewable, Often Petroleum-based
2	Environmental Impact	Low, Sustainable	High, Manufacturing & Disposal Concerns
3	Biodegradability	Yes	Generally No
4	Weight	Lightweight	Can vary, but often comparable
5	Production Cost	Potentially Low	Variable, often higher
6	Customization	Highly Flexible	Can be customized, but often more complex
7	Chemical Content	Generally Safe	Can contain VOCs and other potentially harmful chemicals

4. Current Status

Fungal-based sound absorbers are still in the early stages of proof of concept and commercialization. Preliminary research has demonstrated their efficacy, however challenges like scalability, durability, and resistance to environmental factors remain (Islam et al., 2020). Start-ups and research institutions are actively exploring bioengineered solutions to enhance fungi's structural and acoustic properties. Countries with strong sustainable development policies, such as the Netherlands and Denmark, are leading efforts to integrate fungi-based materials into green building initiatives.

Table 3: Challenges and Opportunities for Fungi-Based Sound Absorbers

S.No	Challenges	Opportunities
1	Scalability of Production	Utilizing existing agricultural infrastructure
2	Durability and Longevity	Developing surface treatments and protective coatings
3	Resistance to Environmental Factors	Exploring fungal strains with inherent resistance
4	Standardization and Regulations	Establishing industry standards and guidelines
5	Cost Competitiveness	Optimizing production processes and material properties

5. Applications in Relevant Fields

1. Fungi-based acoustic panels are increasingly used in sustainable building designs to enhance indoor sound quality. Mycelium based composite materials have a large potential to replace the synthetic materials in architectural systems and can propose biodegradable alternatives as sound absorbing

materials. Sound absorbing materials may help to improve acoustic comfort, which in turn benefit our environment and health systems and productivity.

2. The lightweight and flexible nature of mycelium materials makes them suitable for car interiors and noise-reduction linings (Ali et al., 2019). In vehicles, aircraft, ducts, industrial equipment, and buildings/interiors the mycelial mats can be used as interior lining.
3. Mycelium panels can be employed in outdoor noise barriers along highways and urban landscapes by lining as outer coat on the roofs, walls and floors to minimize the sounds produced externally.
4. Fungi-derived materials are used in home decor, such as wall panels and ceiling tiles, to create eco-friendly living spaces as fungal mycelial mats are more tolerable compared to polystere etc which are the regular used conventional building materials.
5. Factories and workplaces may utilizet from fungi-based matrices a sound absorbers to minimize machine noise and improve worker comfort.

Figure 3: Potential Applications of Fungi-Based Sound Absorbers

Figure 4: Example of a Fungi-Based Acoustic Panel in an Architectural Setting

References

1. Mankowski, J. A., et al. (2020). Environmental impact of traditional sound-absorbing materials. *Journal of Environmental Materials Research*, 18(3), 45-52.
2. Jones, M., et al. (2021). Fungal mycelium materials for sustainable design and engineering. *Nature Sustainability*, 4(6), 456-462.
3. Holt, J., et al. (2018). Porous structures of fungi for acoustic absorption. *Journal of Acoustic Materials Science*, 12(4), 231-243.
4. Islam, M., et al. (2020). Sustainable sound absorbers from mycelium composites. *Green Materials Research*, 15(2), 98-104.
5. Ali, R., et al. (2019). Mycelium-based materials in automotive acoustics. *Automotive Engineering and Innovation*, 24(1), 67-75.
6. Zhou, Y., et al. (2022). Advances in bio-based acoustic materials. *Applied Materials and Interfaces*, 14(10), 2345-2360.
7. Chen, L., et al. (2021). Biodegradable sound-absorbing panels: A review. *Materials Science for Green Innovations*, 9(5), 323-341.