Exploring Sound Absorption Characteristics of Biodegradable Agricultural Wastes for Sustainable Acoustic Solutions

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KEY RESULTS

- Sugarcane fiber (SF) sample with a density 75kg/m^3 has the highest average sound absorption coefficient of 0.94 at 800 Hz low-frequency range (160 - 1000 Hz).
- Coconut fiber (CF) sample with a density of 125 kg/ m^3 has the second highest sound absorption coefficient of 0.91 at 1000 Hz low frequency range (160 - 1000 Hz).
- Lower absorption of sound is observed in a groundnut shell (GS) sample of density 125kg/m^3 with a maximum absorption coefficient of 0.81 at 3150 Hz.

Aims

- Determine the sound absorption coefficient of biodegradable agricultural waste fiber (coconut fiber, sugarcane fiber and groundnut shell).
- Presents biodegradable agricultural waste fiber (coconut fiber, sugarcane fiber and groundnut shell) as a replacement for conventional sound-absorbing materials.
- Adopting a “circular economy” system to convert agricultural waste fiber acoustic absorber.

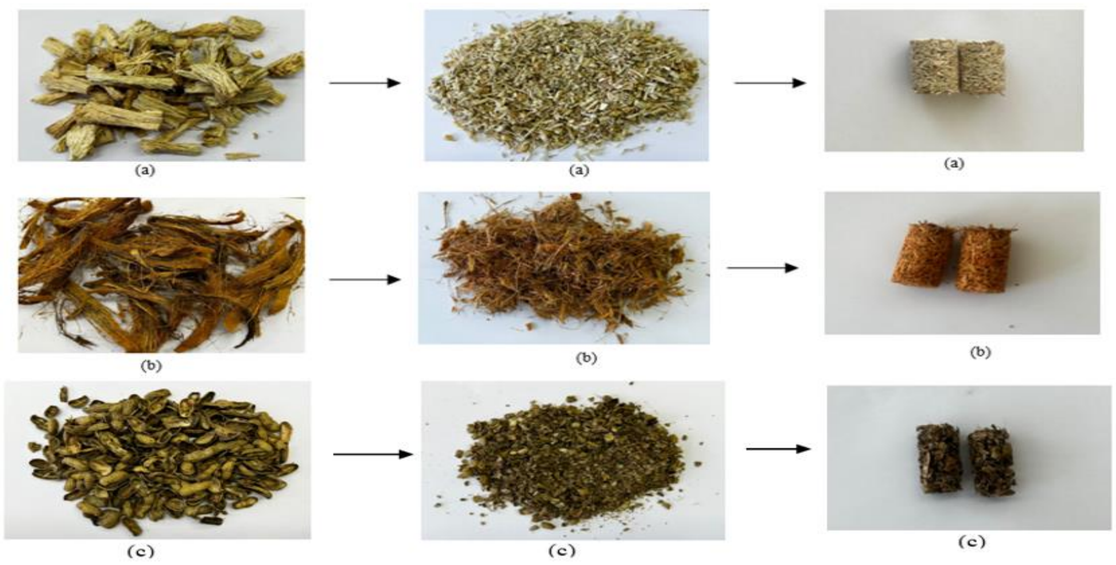
Introduction

Noise pollution is one of the most significant global health problems impacting occupants in mega-cities. The consequences go beyond annoyance to health, emotions, and human behavior. As noise pollution continues to rise, researchers are searching for new solutions and natural fiber is viewed as an ideal application for sound absorption.

The traditional synthetic materials used in the sound insulation industry pose several environmental and health hazards. Given these risks, interest has now turned to the properties of biodegradable natural agricultural waste fibers like coconut fiber, groundnut shell, and sugarcane fiber as alternatives to synthetic fibers. These materials not only show sound absorption properties but are also environmentally - and human-health-friendly. In this study, natural biodegradable agricultural waste fibers (coconut fiber (CF), groundnut shell (GS), and sugarcane fiber(SF)) are proposed for sound absorption application.

MATERIALS AND METHODS

To determine the sound absorption coefficient using the transfer function method using the impedance tube system, six samples were prepared for each material type for which 3 specimens were prepared to evaluate measurement uncertainty. the determination of the sound absorption coefficient adhered to the ISO 10534-2 standard, which involves the transfer function method and the two-microphone technique as specified by the International Organization for Standardization (ISO, 1998).

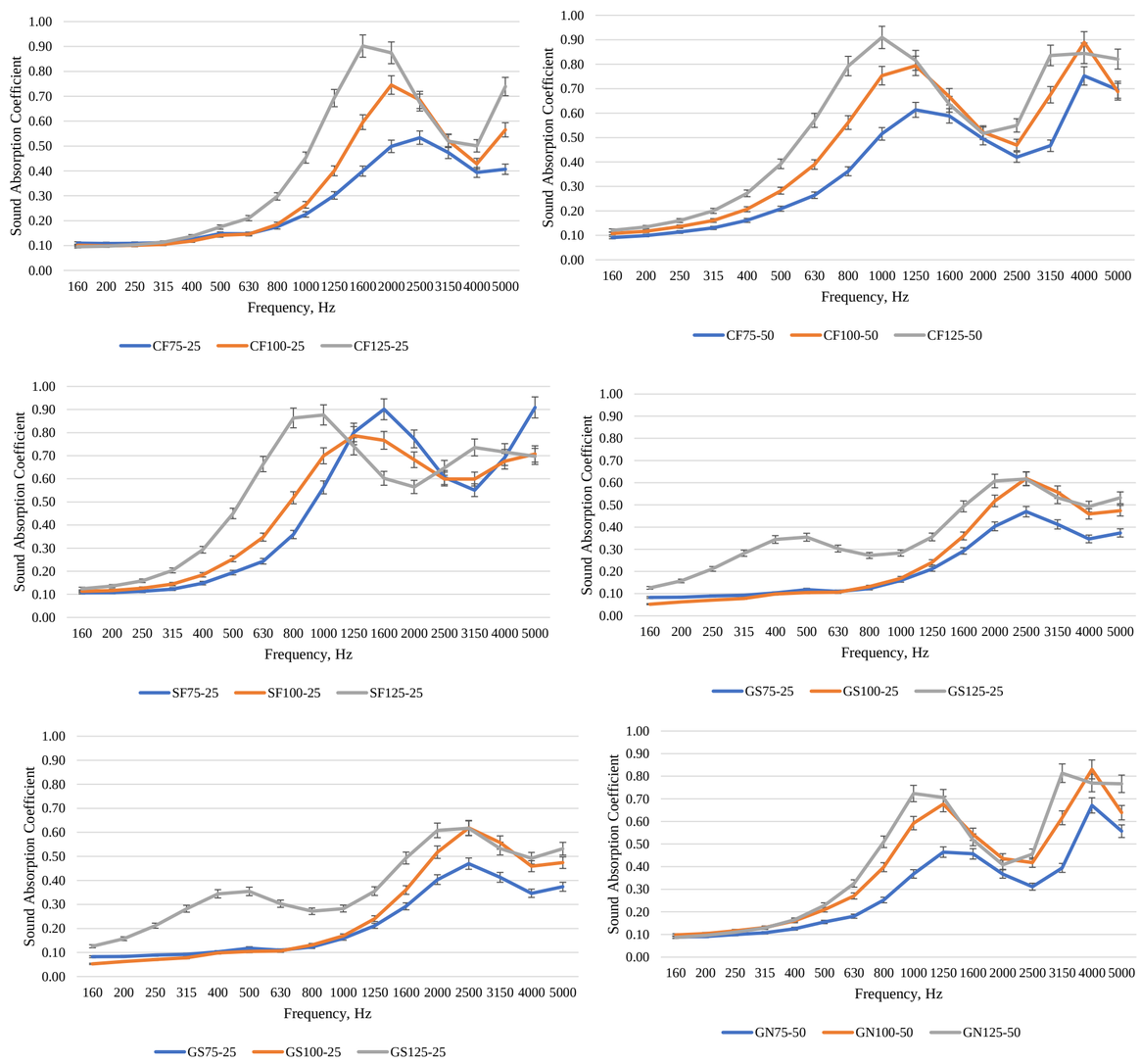


Raw agriculture wastes materials used in the study: (a) sugarcane fiber (b) coconut fiber (c) groundnut shell

TABLE 1. SAMPLE PREPARATION AND COMPOSITION RATIOS

Sample Description	Mass, g	Thickness, mm	Density kg/m3	Binder, wt%
75kg/m3-25	1.2	25	75	100
100kg/m3-25	1.59	25	100	100
125kg/m3-25	1.99	25	125	100
75kg/m3-50	2.39	50	75	100
100kg/m3-50	3.19	50	100	100
125kg/m3-50	3.99	50	125	100

EXPERIMENTAL RESULTS



Conclusion

The experimental results show that the material is potentially a viable alternative to the synthetic materials used for sound absorption purposes. The sugarcane fiber sample, with a density of 75kg/ m^3 in a 50mm mold, shows the highest average sound absorption coefficient of 0.94 at a frequency of 800 Hz, particularly in the low-frequency range. This was followed by the coconut fiber sample, with a density of 125kg/ m^3 in a 50 mm mold, demonstrating the second-highest coefficient of 0.91 at a frequency of 1000 Hz, also in the low-frequency range. Groundnut shell shows comparatively lower sound absorption, with the highest coefficient recorded at 0.81, with a sample density of 125kg/ m^3 in a 50mm mold at a frequency of 3150.
Sound absorption at lower frequencies is critical in environments like classrooms and libraries where the dominant frequency content ranges from 20 to 200 Hz.