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Conversion of Lignocellulosic Waste: Artichoke Leaf-Based Bio-Composite Sound Insulation Panels

Mert Eroğlu, Ali Tuna Balcı

KeyWords
Acoustics, Artichoke Leaf, Biocomposite, Chemical Modification, Lignocellulosic Waste, Sound Insulation, Upcycling.

ABSTRACT

The aim of this project is to develop an environmentally friendly and economical bio-composite sound insulation panel from artichoke leaves, which are an agricultural waste product. In the study, artichoke leaves were subjected to two different processes: boiling in water and chemical fiber extraction using NaOH. The resulting fibers were formed into panels using a starch binder and subjected to acoustic performance tests after the drying stage. Sound transmission loss measurements were conducted using a closed test chamber and the Decibel Meter mobile app; the sound intensity behind the panel was compared to the reference sound emitted by a speaker. Experimental measurements revealed that both panel types exhibited significant sound absorption properties. While the water-boiled panel was effective at certain frequencies, the panel treated with NaOH was observed to absorb sound energy at a higher rate. The findings indicate that natural fibers derived from artichoke leaves constitute a viable alternative material for sound insulation. The project demonstrated, through both applied and experimental data, that a sustainable waste product can be transformed into a functional product.

Project Purpose

The aim of this project is to develop an environmentally friendly, economical, and functional bio- composite sound insulation panel by utilizing artichoke leaves, which are considered agricultural waste. In addition to highlighting the use of sustainable materials, the study aims to provide participants with hands-on experience in biomaterials, acoustic performance measurements, and engineering design processes. Testing the processing of artichoke leaf fibers, their conversion into composite panels, and the acoustic insulation properties of the produced panels will provide participants with an interdisciplinary learning perspective. Additionally, the project aims to present a model application in the context of waste management and environmental sustainability; to highlight the potential of natural fibers from a materials science perspective; and to develop an innovative approach to the reuse of agricultural waste. In this regard, the study aims to generate value at both the scientific and societal levels by integrating sustainability, recycling, and engineering applications.

1. Introduction

1.1 Research Questions

1. Can bio-composite panels derived from artichoke leaf fibers provide a sound transmission loss (Transmission Loss) suitable for use as a sound insulation material?

A. How does the sound insulation performance of panels produced from artichoke leaf fibers subjected to chemical modification with NaOH differ from that of samples treated only with physical processes using water?

B. How does the sound transmission loss of artichoke leaf-based panels vary depending on the applied sound frequency (low – medium – high frequency)?

C. How do changes in fiber separation quality (fiber integrity, porosity, fiber-cellulose structure) affect the material’s sound absorption capacity?

1.2 Hypotheses

H_1: Panels produced from artichoke leaf fibers chemically treated with NaOH will provide higher sound transmission loss (dB) compared to panels obtained by boiling in water alone, as they are more thoroughly de-lignified and form a more homogeneous fiber structure.

H_2: The micro-pores in the composite structure composed of artichoke fibers and starch binder compress sound waves within the internal structure, creating energy loss due to friction. Therefore, the sound intensity within the panel will decrease significantly compared to the control group.

H_3: Artichoke leaf-based biocomposite panels will provide higher sound transmission loss at high frequencies (2000–4000 Hz) compared to low frequencies (250–500 Hz) due to their porous and fibrous structure.

1.3. Variables

In this study, the independent variables consist of two different processing methods applied to artichoke fibers (boiling in water and chemical modification with NaOH) and the tested sound frequencies. The dependent variable of the study is defined as the sound transmission loss of the panels (in dB). To ensure the reliability of the experimental process, the speaker’s initial sound level, the distance between the speaker–panel–measuring device, the starch concentration used, drying temperature and duration, the volume and material of the test chamber, and the background noise level were kept constant as control variables.

1.4 Agricultural Production and Waste Potential of Artichokes

Artichoke is a Mediterranean-origin plant species with high nutritional value and is widely used in both human nutrition and the pharmaceutical industry (Kenanoğlu & Saner, 2013). In recent years, there has been a significant increase in both the area under artichoke cultivation and production volume, both globally and in Turkey. In Turkey, traditional artichoke production is concentrated primarily in the provinces of İzmir, Bursa, Aydın, Antalya, and Adana (Kenanoğlu & Saner, 2013).

In 2011, a total of 33,460 tons of conventional artichokes were produced across 2,444 hectares in Turkey. In the same year, a total of 91.38 tons of organic artichokes were produced in the provinces of Adana, Antalya, Bursa, Eskişehir, Istanbul, Izmir, Manisa, and Zonguldak (Kenanoğlu & Saner, 2013). According to foreign trade data, the export value of conventional artichokes in 2011 was It is observed that the value of exports was $137,506, while the value of imports was $2,874,455, and that imports were significantly higher than exports (Kenanoğlu & Saner, 2013).

In terms of pricing, it was found that organic artichoke prices at both the producer and retail levels were higher than those of conventional artichokes. This situation is attributed to the limited production of organic artichokes and the increase in market demand (Kenanoğlu & Saner, 2013). The study in question highlights developments in traditional and organic artichoke production in Turkey, the state of foreign trade, marketing channels, and price formation, and offers various recommendations regarding production and marketing

1.5. Chemical Composition of Artichoke Leaves (Cellulose, Lignin, Pectin)

Artichoke leaves—both the large leaves forming the plant's stem and the tough outer bracts in the edible portion—chemically fall into the lignocellulosic biomass category. This classification indicates that the structure consists primarily of polysaccharides such as cellulose, hemicellulose, lignin, and certain amounts of pectin (Fengel & Wegener, 1989; Sjöström, 1993).

1.5.1. Cellulose

Cellulose is the most abundant organic polymer in the plant kingdom and forms the basic skeleton of the plant cell wall (Sjöström, 1993).

The primary function of cellulose is to provide structural integrity and mechanical strength to the plant cell. Chemically, it is formed by the assembly of long β-D-glucose chains, which organize into strong structures called microfibrils (Fengel & Wegener, 1989).

Cellulose in artichoke leaves forms the "skeleton" of the leaf tissue, enabling the plant to stand upright and the bracts to maintain their shape. In addition, a large portion of the artichoke's characteristic fibrous texture is derived from cellulose, and the leaf is considered an important source of insoluble dietary fiber (Lattanzio et al., 2009).

1.5.2. Lignin (Lignin)

Unlike cellulose and hemicellulose, lignin is not a carbohydrate; it is a chemically complex phenolic polymer containing aromatic rings (Sjöström, 1993). It is recognized as the primary component that gives plants their "woody" properties and plays a critical role in conferring strength to lignocellulosic biomass.

Lignin's primary function is to act as a "cement" that binds cellulose and hemicellulose fibers together by intercalating between them (Fengel & Wegener, 1989). This structure makes the plant cell wall harder, more hydrophobic, and mechanically stronger. Because lignin has a highly branched and irregular polymer structure, its degradation is quite difficult in both biological and chemical processes (Sarkanen & Ludwig, 1971).

The presence of lignin in artichokes is the primary determinant of the hard, fibrous, and woody texture of the outer leaves (bracts). By holding cellulose fibers together, it imparts structural strength, makes the tissue waterproof, and contributes to the plant's resistance to decay or insect attacks (Lattanzio et al., 2009).

1.5.3. Pectin

Pectin, along with lignin and cellulose, is one of the fundamental components of the plant cell wall, but it stands out particularly for its “binding” role. By forming the main component of the middle lamella that holds plant cells together, it acts almost like an intercellular gel or adhesive (Ridley et al., 2001). Structurally, it is a complex polysaccharide composed of sugar acids and constitutes an

important part of soluble dietary fiber (Voragen et al., 2009).

In artichokes, pectin is found in high concentrations particularly in the bracts and stem tissue. Indeed, studies indicate that fresh artichokes contain approximately 4.5–5% pectin in their edible bracts and (Femenia et al., 1998). While lignin and cellulose provide structural rigidity and durability, pectin allows cells to bind tightly together. For this reason, the artichoke leaf possesses the qualities of a material that is both mechanically strong and has high biomass potential, thanks to a cellulose-based skeleton, lignin filling the spaces between this skeleton, and pectin holding all these cellular structures together.

1.6. Known Bioactive Compounds in Artichoke Leaves (e.g., Cynarin, Antioxidants)

Artichoke leaves are an extremely rich plant-based raw material not only due to their fibrous structure but also because of the bioactive compounds they contain. Historically used extensively in the Mediterranean diet and traditional medicine, artichoke leaves contain various phenolic compounds, flavonoids, and powerful antioxidants, particularly cynarin (Lattanzio et al., 2009). These components confer important biological properties to artichokes, such as antioxidant capacity, support for liver function, and aid in digestion (Gebhardt, 1997). The literature contains numerous studies on the hepatoprotective (liver-protective) effects of artichoke leaves, their free radical scavenging capacity, and their role in regulating lipid metabolism (Bundy et al., 2008).

Consequently, both the structural properties and the bioactive component profile of artichoke leaves make them a valuable resource for research in food, health, and sustainable biomaterials.

1.7. Bioactive Components of Artichoke Leaves: Phenolic Acids, Flavonoids, and Other Components

Artichoke leaves are a plant-based source that exhibits strong bioactive properties due to their high content of phenolic acids, flavonoids, and prebiotic fiber. Their lignocellulosic structure and rich phytochemical profile make it a valuable species for both food science and biomaterial research. Particularly due to the high concentration of phenolic compounds, artichoke ranks among plants with high antioxidant capacity (Lattanzio et al., 2009).

1.8. Phenolic Acids

Phenolic acids are among the primary bioactive compounds responsible for the majority of the therapeutic effects of artichoke leaves. The most notable compound in this group is cynarin, a chemical derivative of dicaffeoylquinic acid. Cynarin is known to have a protective effect on liver health; it increases the resistance of hepatocytes to toxic substances and supports the regeneration of liver cells (Gebhardt, 1997). Additionally, cynarin facilitates fat digestion by stimulating bile production through its cholagogue effect and contributes to alleviating issues such as bloating and indigestion in the gastrointestinal system (Bundy et al., 2008). Various studies have also highlighted that, thanks to its positive effects on lipid metabolism, it may help reduce LDL cholesterol and increase HDL cholesterol levels (Lattanzio et al., 2009).

Another phenolic acid found in significant amounts in artichoke leaves is chlorogenic acid. With its strong antioxidant capacity, chlorogenic acid reduces cellular damage caused by free radicals, plays a role in controlling inflammation, and may exhibit a regulatory effect on glucose metabolism (Grosso et al., 2014).

1.9. Flavonoids

Artichoke leaves contain various flavonoids with pronounced antioxidant and anti-inflammatory properties. These compounds enhance both the plant's biological activity and its cellular protective capacity (Lattanzio et al., 2009).

Among these, luteolin is one of the most potent antioxidant flavonoids in artichokes and is notable for its anti-inflammatory and potential anticancerogenic properties. Luteolin interacts synergistically with cynarin and chlorogenic acid to increase the artichoke's total antioxidant capacity (Lattanzio et al., 2009).

Another important flavonoid, rutin, supports the strengthening of capillary vessel structure and provides vascular protection against oxidative stress (Femenia et al., 1998). Apigenin, found in artichoke, apigenin is a compound known for its anti-inflammatory effects and contribution to cellular calming mechanisms (Lattanzio et al., 2009).

1.10. Other Bioactive Compounds

Inulin, which is found in high concentrations in the leaves, stems, and flower structures of artichokes, acts as a prebiotic fiber to support the nutrition of the gut microbiota. By promoting the proliferation of probiotic bacteria, inulin helps regulate the digestive system, strengthen immune functions, and maintain gastrointestinal health (Grosso et al., 2014).

Additionally, artichoke leaves are rich in essential micronutrients such as potassium, magnesium, vitamin C, and vitamin K. Potassium is critical for cardiovascular balance; magnesium for muscle and nerve function; vitamin C for antioxidant defense; and vitamin K for bone health and blood clotting processes (Lattanzio et al., 2009).

When these findings are considered together, the phenolic profile and bioactive compounds of artichoke leaves make it an important natural resource for both nutritional science and biomaterial- focused applications.

2. Method:

In this study, fiber-based biocomposite panels were produced from artichoke leaves using two different pretreatment methods. The objective of both methods was to appropriately break down the lignocellulosic structure, release the fibers, and combine them with a starch-based natural binder to compare their sound insulation performance. The production steps for both methods are detailed below.

2.1. Preparation:

Artichoke leaves were obtained fresh and subjected to a preliminary cleaning process at the facility. After washing, the leaves were left on paper towels at room temperature for 10–15 minutes to drain excess water. They were then separated for the two distinct production techniques.

Method A (Boiling in Water):

65.66 g of artichoke leaves were boiled in 500 mL of distilled water, then blended and strained through cheesecloth to obtain a fiber-rich paste. The resulting fibrous structure was kneaded with starch to form a dough.

Figure 2.1.1.

Figure 2.1.2.

Method B (Fiber Extraction with NaOH):

Artichoke leaves were boiled in 99.9 g of NaOH solution, separated into fibers, and homogenized using a blender. To remove residual NaOH, the samples were washed with water; after neutralizing the pH, starch was added to form a dough.

2.2. Sheet Formation:

The pulp was divided into 6 equal parts, placed inside a specially prepared rectangular box/frame, and pressed to form a sheet with a smooth surface.

2.3. Drying Process:

The samples obtained using both methods were subjected to the same drying protocol. The drying steps were car-

ried out as follows:

Figure 2.3.1. *Drying process*

- **Pre-drying (30 °C)**

The samples were pre-dried on Silpat/parchment paper in an oven at 30 °C, then allowed to rest at room temperature for 10 minutes. This step was performed to allow water to slowly evaporate from the surface and to help the sheets retain their shape.

- **Medium-Temperature Drying (50 °C – 1 hour)**

After resting, the samples were placed back in the oven and dried at 50 °C for 1 hour. This step ensured that the sheets' basic
structure became stable.

- **Overnight Curing (Room Temperature)**

After the oven process, the plates were allowed to rest at room temperature overnight. This controlled cooling and moisture
equilibration step reduced the risk of cracking and deformation.

- **Balanced Drying (40 °C – 2 hours)**

The next day, the samples were placed back in the oven and dried for an additional 2 hours at 40 °C. This

stage was designed to remove the remaining moisture slowly and in a controlled manner.

- **Final Drying at Room Temperature**

After the oven process was completed, the panels were left to dry at room temperature, and the samples were turned at regular intervals during this process. Once the panels were completely dry, they were ready for experimental analysis.

2.4. Sound Insulation Test

Sound insulation measurements were conducted in a controlled environment using the Decibel Meter app to evaluate the acoustic performance of artichoke leaf-based bio-composite panels. The primary objective of these measurements was to determine how much the panels reduced sound levels by comparing the sound level before the panel was installed with the sound level after installation.

The experimental setup consisted of a fixed-position speaker, a measurement device (phone + Decibel Meter app), and various boxes capable of completely blocking the space between the speaker and the microphone. To ensure accurate measurements, ambient noise was minimized, the speaker– microphone distance was kept constant in each trial, and the students used the same sound level in all tests.

In the pre-test, a wide-range sound signal was played through the speaker, and the sound level inside the box was recorded in the absence of a sample (as shown in Figures 3 and 4). This value was used as the baseline reference for comparisons. Subsequently, three different conditions were tested:

1. Empty box
2. Artichoke leaf panel produced by separating the fibers with water
3. Artichoke leaf panel defibrated using NaOH

After each panel was placed between the speaker and the microphone, measurements were taken again using the same audio signal, and each test was repeated at least three times, with the average values included in the evaluation. During this process, the extent to which the samples reduced sound intensity was directly observed, and the acoustic behaviors of the materials were compared.

The measurement results showed that the panel fiberized with NaOH provided higher sound reduction compared to the panel prepared with water, as shown in Figure 1. This can be attributed to the chemical fiber separation making the panel's internal structure more homogeneous and enabling it to disperse and absorb sound waves more effectively. The panel fiberized with water, despite having a more natural and irregular pore structure, still demonstrated a significant insulation performance.

Through this study, students experimentally observed how sound waves attenuate depending on the material struc ture and understood how factors such as porosity, fiber structure, and panel thickness affect acoustic performance. The findings demonstrate that agricultural waste, such as artichoke leaves, can be transformed into an effective sound insulation material when properly processed.

Figure 2.4.1. *Measurement from the NaOH-based panel*

Figure 2.4.2. *Measurement from a water-based panel*

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Figure 2.4.3. Measurement inside an empty box

Figure 2.4.4. Measurement taken directly from the speaker

3. Project Work-Time Schedule

MONTHS						
Task Description	July	August	September	October	November	December
Literature Review			x	x	x	
Experimental Study			x	x	x	
Data Collection and Analysis			x	x	x	
Writing the Project Report				x	x	x

4. Findings

In this section, data obtained by measuring sound intensity emitted from the speaker in different environments were evaluated comparatively. Measurements were recorded in dB(A), and the results were analyzed using the "Outdoor Environment" value as a reference.

Ölçüm Koşulu	Ses Şiddeti (dB)	Referansa Göre Azalma (dB)	Azalmanın Yorumu
Dış ortam (Referans)	108,8	–	–
Boş kutu	96,8	12,0	Kutu duvarının sınırlı fiziksel engeli
Su ile ayrıştırılmış panel	74,0	34,8	Lifler arası doğal gözeneklerde artmış sürtünme ve viskoz kayıplar
NaOH ile ayrıştırılmış panel	71,0	37,8	Lignin çözünmesi sonrası yüksek gözeneklilik, daha uzun akustik yol

4.1. Evaluation of Control Groups

"The open sound source designated as the reference point in the experiments produced noise at an average intensity of 108 dB. In measurements conducted using corrugated cardboard (a standard packaging material), the sound level dropped to 96 dB. This indicates that standard cardboard provides only a 12 dB reduction in sound insulation, meaning it is insufficient for noise reduction."

4.2. Performance of Artichoke-Based Bio-Composites

"The artichoke leaf-based panels developed demonstrated exceptional insulation performance compared to cardboard boxes in both production methods (water and NaOH).

- Samples boiled in water reduced sound levels to 74 dB,
- while samples modified with NaOH reduced it to 72 dB."

"These results demonstrate that the material produced from artichoke waste reduces the intensity of the sound source by approximately 36 dB (a very significant difference on a logarithmic scale). Our material provided more than twice the sound insulation compared to standard cardboard (since decibels are logarithmic, the 24 dB difference means that over 99% of the sound energy was blocked)."

4.3. Effect of the Chemical Treatment (NaOH)

"The data obtained show that the sample treated with Sodium Hydroxide (NaOH) (~72 dB) provides better sound insulation than the sample boiled only in water (~74 dB). This finding confirms Hypothesis 1.

The NaOH treatment dissolved the lignin in the artichoke leaf, releasing the cellulose fibers and promoting the formation of more micro-pores within the material's internal structure. Sound waves became more trapped within these pores and were dampened as they converted into heat energy through friction."

**Note: Since the decibel is a logarithmic unit, even a 3 dB reduction means the sound energy is halved. A 24 dB difference signifies a massive reduction in sound energy.*

- ***Water panel:*** *34.8 dB reduction → Sound is heard at approximately **1/8 to 1/9** of the original level*
- ***NaOH panel:*** *37.8 dB reduction → Sound is heard at approximately **1/12 to 1/13** of the original level*

This demonstrates that the NaOH panel absorbs the majority of the sound energy (converting it into heat).

The artichoke leaf panel we produced attenuates 99.975% of the incident sound energy, allowing only 0.025% to pass through to the back

In physics, "Sound Energy" (Power) and "Sound Loudness" (Loudness – Perception) are different things.

- Sound intensity (energy) is a physical quantity. It is expressed in watts per square meter (W/m²).
- Sound loudness, however, is the ear's perception of sound and operates logarithmically.
- The difference in sound level is calculated using the following formula:

$$\Delta L = 10 \log \left(\frac{I_1}{I_2} \right)$$

- So, a 10 dB decrease means the energy has decreased by a factor of 10. A 20 dB decrease means the energy has decreased by a factor of 100.
  A 30 dB decrease means the energy has decreased by a factor of 1,000.
- Therefore, if the drop in dB is very large, this actually indicates that a much larger portion of the energy has been lost.

For this reason, measurements in dB are values scaled according to human perception and do not directly indicate the actual ratio of energy.

Outdoor environment: 108.8 dB After
NaOH panel: 71 dB

Difference: ≈37 dB

Energy ratio: $10^{\frac{37}{10}} \approx 5012$

This means:

- The energy passing through to the back of the panel is approximately one-fifth of one percent of the energy at the front.

- In other words, the panel has attenuated 99.98% of the sound energy. (Scientifically accurate: between 99.980% and 99.984%)

Considering experimental measurements and the dB–energy relationship:

Artichoke leaf-based bio-composite panels have demonstrated a high level of sound absorption.

The panel produced by fiber separation using NaOH has demonstrated a sound energy attenuation efficiency of 99.98% relative to the external environment.

This value is comparable to the sound absorption performance reported in the literature for natural fiber-reinforced composites such as jute, flax, and sisal, and even indicates a performance level exceeding the values reported in some studies. The success of natural fibers in sound insulation stems from their irregular, porous, and micro-voided structures. The structure of artichoke leaf fibers, in this regard, offers a high surface area and high porosity, causing sound waves to undergo multiple reflections and energy loss due to friction between the fibers.

This study demonstrates that an agricultural waste product such as artichoke leaves can be transformed into a high-performance, eco-friendly sound insulation material. Additionally, it was determined that the chemical (NaOH) separation of the fibers significantly enhances sound absorption performance by increasing the surface roughness of the fibers. This result is consistent with literature findings indicating that natural fibers become more effective following alkaline treatment.

Overall, the findings suggest that panels produced from artichoke leaf fibers could serve as a renewable, economical, low-carbon-footprint, and high-performance acoustic insulation alternative. The project results point to significant potential in terms of both environmental sustainability and materials science.

5. Recommendation

The findings obtained in this study demonstrate that artichoke leaf-based biocomposite panels possess the qualities to be considered among sustainable acoustic materials. However, standardizing production processes is of great importance for the material to be addressed more comprehensively from both scientific and industrial perspectives. Optimizing variables such as fiber size, fiber ratio, chemical treatment duration, binder quantity, and drying-pressing parameters will contribute to both ensuring reproducibility and improving mechanical and acoustic performance. Additionally, a more detailed examination of frequency-based acoustic behavior will strengthen the scientific basis for determining in which application areas the material will be most effective.

For biocomposite panels to be widely used, it is necessary to comprehensively evaluate not only their sound insulation performance but also their physical properties, such as mechanical strength, water absorption behavior, and resistance to moisture and temperature. In this regard, it is recommended to diversify the pretreatments applied to the fibers, compare NaOH concentrations, test enzymatic or mechanochemical methods, and modify the fibers with biopolymer coatings. Additionally, improving safety parameters such as fire resistance will enhance the material's applicability in the construction sector. Given the natural porous structure of artichoke fibers, analyzing thermal insulation performance will enable the panel to be transformed into a dual-function material.

In future research, diversifying binder types, optimizing panel geometry and pore structure, developing multi-layered structures, and testing different surface designs could significantly improve the material's acoustic efficiency. The widespread production of artichokes in Turkey presents a significant opportunity for pilot-scale production studies; the material's environmental and economic feasibility can be assessed through studies such as cost analysis, carbon footprint calculations, and production line design. Finally, testing the findings obtained in the laboratory in real-world application areas such as classrooms, interior walls, or studios will demonstrate the material's practical performance and strengthen the product's industrial viability.

Conclusion

In this study, the basic acoustic performance of artichoke leaf-based biocomposite panels was investigated, and the sound insulation capacities of samples produced using two different fiberization methods were compared. Experimental measurements were conducted using a decibel meter in a constant sound field generated by a speaker. In the reference condition, the speaker output was recorded at 110 dB. When an empty cardboard box was placed between the speaker and the measuring device, the value was measured at 96.8 dB; this level indicated that the cardboard material had only a limited attenuation effect.

The reduction in sound intensity increased significantly with the placement of biocomposite panels. The 74 dB value measured in the sample prepared by boiling in water corresponds to a sound reduction of approximately 36 dB, while the 71.1 dB value measured in the sample fiberized with NaOH corresponds to a sound reduction of approximately 39 dB. These results demonstrate that both methods produce a significantly higher sound attenuation effect compared to cardboard. The higher performance of the NaOH-treated sample suggests that the chemical defibration process enhances structural homogeneity, thereby creating a more effective porosity and internal damping mechanism. Studies in the literature on the acoustic properties of lignocellulosic materials also indicate that fiber separation enhances the material's porosity, thereby improving sound absorption behavior; the findings obtained are consistent with this trend.

However, the study has certain limitations. The density, thickness, and moisture content of the samples were not standardized; the tests were conducted in a limited laboratory setup rather than in a controlled acoustic chamber. Measurements were taken only in terms of total sound level, and a frequency- dependent performance analysis could not be performed. Therefore, the results obtained should be considered not as a definitive criterion for classifying the material, but rather as a preliminary assessment for future studies.

Overall, artichoke leaf-based biocomposites appear to offer significant potential for sound insulation. Given that they are both environmentally friendly and a low-cost raw material, the feasibility of using such bio-based materials in acoustic panels, interior cladding, or packaging-based sound control applications warrants further investigation. Future studies are recommended to evaluate the effects of different chemical treatments, frequency-based absorption coefficients, mechanical strength performance, and long-term stability.

In conclusion, this study demonstrates that a low-value agricultural waste product such as artichoke leaves holds significant potential for sound insulation applications when converted through appropriate processing steps. The data obtained indicate that bio-based composites can serve as competitive alternatives not only in terms of environmental sustainability and waste management but also in terms of acoustic performance. Despite the study's limited testing conditions, the damping levels it reveals indicate that chemical fiberization processes lead to significant improvements in the material's microstructure.

In this context, artichoke leaf-based panels appear to be a promising candidate for an innovative, economical, and sustainable material class in both building physics and interior acoustics, provided they are supported by standardized production and more comprehensive acoustic testing in the future.

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References

Arenas, J. P., & Crocker, M. J. (2010). Recent trends in porous sound-absorbing materials. Sound & Vibration, 44(7), 12–17.

Bektaş, Z. K., & Saner, G. (2013). Türkiye'de enginar üretimi ve pazarlaması. Uludağ Üniversitesi Ziraat Fakültesi Dergisi, 27(1), 115–128.

Bundy, R., Walker, A. F., Middleton, R. W., & Booth, J. (2008). Artichoke leaf extract (Cynara scolymus) reduces abdominal pain and improves quality of life in patients with irritable bowel syndrome: A pilot study. Journal of Alternative and Complementary Medicine, 10(4), 667–669.

Bundy, R., Walker, A. F., Middleton, R. W., & Booth, J. (2008). Artichoke leaf extract (Cynara scolymus) reduces plasma cholesterol in otherwise healthy hypercholesterolemic adults: A randomized, double blind placebo controlled trial. Phytomedicine, 15(9), 668–675.

Ceylan, C., Bayraktar, O., Atcı, E., & Sarraf, Ş. (2017). Pektin kaynağı olarak taze bütün enginar ve enginar konserve atığı. Gıda, 42(4), 438–446.

Femenia, A., Robertson, J. A., Waldron, K. W., & Selvendran, R. R. (1998). Cauliflower (Brassica oleracea L.), globe artichoke (Cynara scolymus L.) and chicory witloof (Cichorium intybus L.) processing by-products as sources of dietary fibre. Journal of the Science of Food and Agriculture, 77(1), 78–84.

Fengel, D., & Wegener, G. (1989). Wood: Chemistry, ultrastructure, reactions. Walter de Gruyter.

Gebhardt, R. (1997). Antioxidative and protective properties of extracts from leaves of the artichoke (Cynara scolymus L.) against hydroperoxide-induced oxidative stress in cultured rat hepatocytes. Toxicology and Applied Pharmacology, 144(2), 279–286.

Grosso, G., Stepaniak, U., Topor-Mądry, R., Szafraniec, K., & Pająk, A. (2014). Estimated dietary intake and major food sources of polyphenols in Poland. Nutrients, 6(5), 2035–2050.

Kenanoğlu, İ., & Saner, G. (2013). Türkiye'de geleneksel ve organik enginar üretimi: Üretim, dış ticaret, pazarlama yapısı ve fiyat oluşumu. Ege Üniversitesi Ziraat Fakültesi Dergisi, 50(1), 71–80.

Koizumi, T., Tsujiuchi, N., & Adachi, A. (2002). The development of sound absorbing materials using natural bamboo fibers. High Performance Structures and Composites, 4, 157– 166.

Lattanzio, V., Kroon, P. A., Linsalata, V., & Cardinali, A. (2009). Globe artichoke: A functional food and source of nutraceutical ingredients. Journal of Functional Foods, 1(2), 131–144.

Ridley, B. L., O'Neill, M. A., & Mohnen, D. (2001). Pectin: Structure, biosynthesis, and oligogalacturonide-related signaling. Phytochemistry, 57(6), 929–967.

Sarkanen, K. V., & Ludwig, C. H. (1971). Lignins: Occurrence, formation, structure and reactions. Wiley-Interscience.

Sjöström, E. (1993). Wood chemistry: Fundamentals and applications (2nd ed.). Academic Press.

Voragen, A. G. J., Coenen, G.-J., Verhoef, R. P., & Schols, H. A. (2009). Pectin, a versatile polysaccharide present in plant cell walls. Structural Chemistry, 20, 263–275.