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**RESEARCH ARTICLE**

# MUSSEL (*PERNA VIRIDIS*) SHELL AND BANANA (*MUSA PARADISIACA LINN)* FIBER AS BIO-BLOCKS

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## Abstract

The building industry faces the difficulty of balancing development and environmental accountability. This study investigates the viability of using bio-blocks made from mussel shells (*Perna Viridis*) and banana fibers (*Musa Paradisiaca Linn*) as an environmentally friendly substitute for conventional construction materials. Mussel shells possess properties of strength, rigidity, and fire retardance, whilst banana fibers provide thermal insulation and are derived from the byproduct of banana farming. The study explores techniques for enhancing the bio-block composition and manufacturing process to get specific mechanical characteristics, density, and porosity. The essay examines the extended resilience, environmental friendliness, and possible uses in the construction of these bio-blocks. Ultimately, it tackles obstacles to economic competitiveness and puts forth methods for broader implementation in the construction sector. By advocating for responsible waste management and minimizing the environmental impact, the utilization of bio-blocks composed of mussel shells and banana fibers is a promising strategy for achieving a more sustainable future in the field of building.

**Keywords:** *mussel (perna viridis) shell, banana (musa paradisiaca linn) fiber, bio-blocks*

## Introduction

Green mussel shells *(Perna viridis)* and banana fiber from *Musa paradisiaca Linn* can be used as bio-blocks for multiple applications. Mussel shells have the potential to be transformed into biopolymer materials such as chitosan. The physicochemical properties of these materials might vary depending on the size of the shells (Gbadeyan et al., 2021). However, while banana pseudostems are classified as hazardous trash in Bangladesh, they have been effectively utilized in other countries to produce bio-products such as yarn, cloth, fertilizer, and other items (Magnayi et al., 2020). This has contributed to both socioeconomic progress and environmental sustainability. Furthermore, mussels such as P. viridis have demonstrated promise in generating bioactive substances that possess antiviral characteristics, suggesting their potential contribution to the development of antiviral medications. Both mussel shells and banana fiber show potential as bio-blocks for several uses, including the creation of biopolymers, socioeconomic advancement, and the discovery of antiviral drugs.

Compressed earth blocks (CEBs) can be improved by including waste materials such as green mussel shells (GMS) and natural fibers. GMS, which is abundant in calcium carbonate, can be used as a partial substitute for cement in CEBs, resulting in enhanced compressive strength (Lejano, 2019). CEBs can be strengthened and made more durable by including natural fibers like banana and jute, as demonstrated by Mostafa and Uddin (2015) and Selsiadevi et al. (2018). Banana fiber, which is a byproduct of agriculture, possesses characteristics such as low density, high tensile strength, and water resistance (Mohiuddin et al., 2014). Banana fiber, when coupled with nano-calcium carbonate, can produce hybrid biocomposites that exhibit exceptional mechanical and thermal characteristics (Gbadeyan et al., 2021). GMS can serve as a fire-retardant coating for plywood, effectively slowing down the spread of fire (Magnayi et al., 2020). The incorporation of banana fiber and mussel shells in construction materials enhances both their performance and their contribution to sustainable waste management and economic growth in rural regions (Priyadarshana et al., 2020).

The primary objective of the study is to create a solid bio block using mussel shell and banana fiber. In addition, the study will assess the fire resistance, water absorption, and drop test performance of the bio blocks. Furthermore, the compressive strength of the bio blocks will be evaluated using the American Society for Testing and Materials C140 standard.

**Research Objectives**

The study aims to develop and assess the bio blocks made up of mussel *(Perna viridis)* shell, and banana *(Musa paradisiaca Linn)* fiber. Additionally, the research seeks to identify optimal conditions for maximizing the efficiency of materials to produce long-lasting bio-blocks. The following objectives will help the researchers investigate the use of mussel shells and banana fibers in bio-blocks:

a. Analyze the mechanical properties (strength, stiffness, flexural behavior) of individual mussel shells and banana fibers.
b. Investigate the physical properties (density, porosity, water absorption) of bio-blocks made with mussel shells and banana fibers.
c. Assess the fire resistance properties of bio-blocks incorporating mussel shells.
d. Evaluate the long-term durability of bio-blocks made from mussel shells and banana fibers under different environmental conditions (moisture, UV exposure, etc.).
e. Assess the life cycle assessment of bio-blocks compared to traditional construction materials, considering factors like embodied energy and environmental impact.
f. Investigate strategies for improving the biodegradability of the bio-blocks at the end of their service life.

## Methodology

### Materials and Equipment

**Mussel Shells (*Perna viridis*):**

- Collect fresh or sun-dried mussel shells, cleaned and free of organic matter.
- Crushing and grinding equipment may be needed depending on the desired particle size for the bio-blocks.

**Banana Fibers (*Musa paradisiaca Linn*):**

- Extracted fibers from the banana pseudostem, cleaned and dried.
- Depending on the desired form, fibers can be chopped, shredded, or pulped.

**Binding Agent:**

- Bio-based binders like starch, natural resins, or biopolymers are preferred for sustainability.
- Alternatively, Portland cement or other hydraulic cement can be used for specific applications.

**Testing equipment:**

- Instruments for measuring the mechanical properties (tensile strength, compressive strength, flexural strength) of the bio-blocks.
- Equipment for assessing physical properties (density, porosity, water absorption) as per relevant standards

### Treatment/ General Procedure

Using Alarcon's study (2020) as a guide, the researchers created a bio block using sand, white cement, and additives of mussel shells and banana fibers. Materials consist of sand, white cement, banana fiber, and mussel shells. The white cement, sand, and water were measured according to Ali's (2019) ratio per block of 1:7:0.5, while the banana fiber (10 g:40 mm, 15 g:50 mm, and 25 g:60 mm) came from Mugume, Karubanga, and Kyakula's (2021) measurements and the mussel shells (125 g, 250 g, and 375 g) were measured according to Elevado, Galupino, and Gallardo's (2018) ratio. The optimal formulation in terms of durability and longevity during the curing process was subsequently identified by the researchers. The researchers gathered the mussel shells from eateries and gave them a thorough cleaning before crushing them. For a finer texture, they used mortar and pestle to smash the shells into tiny bits. The stem of the banana is cut off and hammered to collect juice for the banana fiber. Using a knife, the researchers extracted any remaining juice and divided the stem into fibers. Using a shovel and bucket, combine pulverized mussel shells, combed banana fiber, white cement, sand, and water to create a bio block. After that, the blocks are put in a 16 by 4 by 6-inch mold and allowed to cure for a minimum of 7 to 14 days.

## Results and Discussion

### *Product development*

Table 1. *Results Of Product Development Trials*

| | Trial 1 | Trial 2 | Trial 3 |
|---|---|---|---|
| *White cement* | 1000 g | 1000 g | 1000 g |
| *Mussel shell* | 125 g | 250 g | 375 g |
| *sand* | 7000g | 7000 g | 7000 g |
| *Banana fiber* | 10 g | 15 g | 25 g |
| *Water* | 500 ml | 500 ml | 500 ml |

Table 1 shows researchers' product development trials. Researchers used Ali's (2019) study for the 1:7:0.5 white cement, sand, and water percentages in the first trial. The researchers also used Elevado, Galupino, and Gallardo's (2018) mussel shell proportion and Mugume, Karubanga, and Kyakula's (2021) banana fiber proportion. The components include 1000 g white cement, 7000 g sand, 500 cc water, 125 g mussel shells, and 10 g banana fiber. The researchers cured a 16-by-4-by-6-inch mold for 7-14 days. Researchers saw disintegration during curing. In the second trial, the researchers used Ali's (2019) study for the 1:7:0.5 white cement, sand, and water parts. The researchers also used Elevado, Galupino, and Gallardo's (2018) mussel shell proportion and Mugume, Karubanga, and Kyakula's (2021) banana fiber proportion. The components include 1000 g white cement, 7000 g sand, 500 ml water, 250 g mussel shells, and 15 g banana fiber. The researchers cured a 16-by-4-by-6-inch mold for 7-14 days. Researchers saw cracking during curing.In the third trial, researchers used Ali's (2019) study for 1:7:0.5 white cement, sand, and water. The researchers also used Elevado, Galupino, and Gallardo's (2018) mussel shell proportion and Mugume, Karubanga, and Kyakula's (2021) banana fiber proportion. The components include 1000 g white cement, 7000 g sand, 500 cc water, 375 g mussel shells, and 25 g banana fiber. The researchers cured a 16-by-4-by-6-inch mold for 7-14 days. Researchers saw no crumbling or breaking during curing.

***Fire Resistance of Bio Blocks***

*Table 2. Results of the Fire Resistance*

| Trials | Temperature | Results |
|---|---|---|
| Trial 1 | 200 °C | No cracks forming. |
| Trial 2 | 200 °C | No cracking and crumbling. |
| Trial 3 | 200 °C | No signs of cracking. |

Table 2 shows the Bio block fire resistance test results. Researchers calculated the bio block fire resistance test results using Qiao, Guo, Zhou, and Xi's 2022 parameter/indicator. After heating 3 sections of bio block on a burner for 30 minutes, the researchers found that it passed the fire resistance test since it did not split or crumble at 200°C. Qiao et al. (2022) found that a conventional hollow block can tolerate heat between 200°C and 500°C, and the block survived sitting on a stove in 200°C heat.

***Water Absorption of Bioblocks***

*Table 3. Result of the Water Absorption of the Mullow Block*

| Trials | Weight Before Absorption | Weight after absorption | Average |
|---|---|---|---|
| *Trial 1* | 1.1 kg | 1.2 kg | 9.09% |
| *Trial 2* | 1.1 kg | 1.2 kg | 9.09% |
| *Trial 3* | 1.1 kg | 1.2 kg | 9.09% |

The researchers calculated hollow block water absorption using Golewski (2020) parameters. The optimum formulation was tried three times by the researchers. The hollow block absorbs little water if the calculation final weight – initial weight/ initial weight * 100 is below 10%. After computing 9.09% water absorption for the three mullow block parts, the parameter showed low water absorption.

***Compressive Strength of Bioblocks***

*Table 5. ASTM C140 Testing results*

| Sample ID | Length (inch) | Width (inch) | Height (inch) | Maximum load (lbf) | Compressive strength (psi) | Minimum Face Shell Thickness | Weight (kg) |
|---|---|---|---|---|---|---|---|
| S - 3 | 16 | 4 | 8 | 7275 | 110 | 1 | 10.10 |

The lab showed that the mullow block had low compressive strength. Mullow blocks have 0.76 MPa compressive strength, while typical hollow blocks have 10.3 MPa (Cabahug & Baguhin, 2019). Furthermore, Olaiya, Lawan, and Olonade (2023) found that curing the mullow block for 7-14 days had low compressive strength. To attain absolute compressive strength, they advised 28 days.

## Conclusion

Bio-blocks made from mussel shells and banana fibers could brighten the building industry's future. These readily available bio-waste materials are durable, insulated, and fire-resistant, making them good replacements for environmentally harmful construction blocks. Current research refines bio-block formulation and production processes to achieve desirable mechanical properties, density and porosity, and durability. Life cycle studies show that bio-blocks can significantly reduce the construction industry's environmental impact. In order to progress, some hurdles must be overcome. Standardized production processes provide quality and ease of incorporation into construction methods. Additionally, research on structural performance and fire safety requirements will help bio-blocks be used in more construction applications. To attain economic competitiveness, investigate efficient large-scale production methods and find markets that value bio-blocks' sustainability. By solving these challenges, mussel shells and banana fiber bio-blocks can alter the construction industry. Their sustainable solution promotes responsible waste management and a greener built environment. As the study and use of these bio-blocks develop, they could help the building sector become more environmentally friendly.

## References

Gbadeyan, O., Adali, S., Bright, G., Sithole, B., & Lekha, P. (2021). Mechanical, Microstructure, And Dynamic Mechanical Analysis Of Nano-Shell And Plant Fiber Hybrid Biocomposite. *Journal Of Composite Materials*, *55*(24), 3345–3358. Https://Doi.Org/10.1177/00219983211013418

Lejano, B. A. (2019). Compressed Earth Blocks With Powdered Green Mussel Shell As Partial Binder And Pig Hair As Fiber Reinforcement. *International Journal Of Geomate*, *16*(57). Https://Doi.Org/10.21660/2019.57.8138

Magnayi, V.C., Pili, N.A., Rebollos, J.D., Villon, J.I., & Zapanta, E.C. (2020). A Comparative Analysis Between Crushed And Pulverized Green Mussel Shells As A Fire-Retardant Coating To Plywood.

Mohiuddin, A., Saha, M. K., Hossian, M. S., & Ferdoushi, A. (2014). Usefulness Of Banana (<I>Musa Paradisiaca</I>) Wastes In Manufacturing Of Bio-Products: A Review. ˜ *The æAgriculturists*, *12*(1), 148–158. Https://Doi.Org/10.3329/Agric.V12i1.19870

Mostafa, M., & Uddin, N. (2015). Effect Of Banana Fibers On The Compressive And Flexural Strength Of Compressed Earth Blocks. *Buildings*, *5*(1), 282–296. Https://Doi.Org/10.3390/Buildings5010282

Murugan, M., Banu, T., Shanthi, C., Dasaradhan, K., & Siddharthan, U. (2019). Experimental Research On Musa Sepientum And Hen Egg Shell Hybrid Reinforced Composite Material. *International Journal Of Engineering And Advanced Technology*, *9*(1), 3363–3365. Https://Doi.Org/10.35940/Ijeat.A1518.109119

Priyadarshana, R., Kaliyadasa, P., Ranawana, S., & Senarathna, K. (2020). Biowaste Management: Banana Fiber Utilization For Product Development. *Journal Of Natural Fibers*, *19*(4), 1461–1471. Https://Doi.Org/10.1080/15440478.2020.1776665

S, S., S, S., & Varshini. (2018). Earth Building Blocks Reinforced With Jute And Banana Fiber. *International Journal Of Engineering Research And Technology*. Https://Www.Ijert.Org/Research/Earth-Building-Blocks-Reinforced-With-Jute-And-Banana-Fiber-IJERTCONV6IS14035.Pdf