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# From Waste to Sustainable Energy: Harnessing Organic By-Products in Developing Eco-Briquettes

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**Abstract**
This study explored the potential of organic by-products, including agricultural residues and industrial waste, to produce eco-friendly briquettes as a sustainable alternative to conventional fuels like charcoal and coal. The research evaluated the efficiency, environmental impact, and practical applications of these eco-briquettes. Biomass, as highlighted by Yunusa *et al*. (2023) [7], played a crucial role in reducing deforestation and greenhouse gas emissions, contributing to the transition to renewable energy sources. Employing a quantitative, quasi-experimental design, the study examined various factors such as material composition, compaction pressure, and drying conditions on briquette performance, including burning time, ignition time, and quality. Data collection involved pre- and post-test assessments, controlled tasks like burning, and efficiency tests comparing briquettes to traditional fuels. Participants used biodegradable materials such as sawdust, coconut fiber, ground coffee, and dry leaves, chosen for their energy potential, cost-effectiveness, and availability. Key findings revealed that mixed-material briquettes had superior ignition times and burning efficiency, with a lifespan of 3661 seconds. These briquettes also showed resistance to water dissolution, indicating stable storage, and partial biodegradability, suggesting long-term environmental sustainability. The study concluded that eco-briquettes offered a promising alternative to traditional fuels, promoting renewable energy adoption and supporting circular economy principles. Recommendations included optimizing briquette production with additional biodegradable materials, conducting long-term biodegradability tests, and enhancing community awareness to drive adoption.

**Keywords:** Eco-briquettes, Sustainable Energy, Waste Management

## Introduction

Briquettes are the alternative fuel energy for charcoal. Due to pollution in the environment caused by the use of burning fossil fuels, developing countries are under pressure to find sources of clean and renewable energy that have limited financial resources and also inadequate technology capacity. Bioenergy from organic waste and briquetting sawdust are clean, renewable, and inexpensive to produce and does not require expensive technology (Yu *et al*.,2022).

According to Hamzah *et al*., (2023) [3], Briquettes are biomass that is an alternative for household energy like LPG. Just like charcoal, briquettes are fuels that are eco-friendly because they are made out of organic waste. Briquettes are organic fuels that are more environmentally friendly compared to charcoal that is made out of wood, briquettes are made out of eco waste.

Worldwide demand is rising and fossil fuels consumption elevated wealth creation, improved the undesirable impact of climate change that emits greenhouse gasses and endangered the health of people. Biomass wastes are not limited to agricultural residue also generated in huge quantities yearly. Inefficient disposing or usage of biomass waste may cause high levels of pollution and toxic impacts to the people. It is possible that these wastes can produce energy-efficient briquettes (Velusamy *et al*., 2022).

This study investigates how briquettes can be produced and the level of their efficiency as a source of energy. Briquettes are kind of like the fast food of charcoal; they're cheap, reliable, and can be found on almost every corner, but you really don't want to know what's in them (Bousel, 2024) [2]. The purpose of this study is to find out the ability of these briquettes to burn relative to the conventional fuels such as wood or charcoal. By testing different combinations of materials, this study aims to identify results in the production of efficient and highly effective briquettes. Additionally, incorporating biodegradable

materials in briquettes will go a long way in curtailing pollution hence making this form of fuel more environmentally friendly. These findings are believed to give understanding on how briquettes could be a sustainable as well as cheaper way of sourcing for energy in homes and small enterprises.

Furthermore, briquettes are made from 100% organic materials, making them a renewable, eco-friendly, sustainable fuel source, and they also help reduce waste since they use organic waste materials. In today's era, more attention is given to things that can improve the environment and lessen climate change, so it is important to have innovative solutions that minimize the negative impact of traditional charcoal. Briquettes, especially those made from organic materials, provide an eco-friendly alternative to traditional charcoal and also contribute to a cleaner and greener future.

Briquettes are a type of fuel made from compressed organic materials to serve as an alternative to charcoal or other fuels, resulting in a cleaner option for our environment. In this research, we will observe the effects and possible changes in outcomes based on the amount of materials we use in making the briquettes. In this research, the independent variable of our study is the amount of the fuels and any material used in making the briquettes. The dependent variable of this study are burning time, Ignition time and the quality of briquettes. Producing briquettes with naturally available waste is an asset. The dependent variables in this study are caused by independent variables.

## Objectives of the Study

This study aims to explore the potential of organic by-products, such as agricultural residues and industrial waste, in developing eco-friendly briquettes. It seeks to address environmental issues by providing a sustainable alternative to traditional fuels like charcoal and coal. The research focuses on evaluating the efficiency, performance, and environmental impact of eco-briquettes, emphasizing their ability to reduce waste, mitigate greenhouse gas emissions, and support renewable energy adoption. By testing various biodegradable materials, the study aims to identify an effective composition for briquettes that are cost-efficient, practical, and eco-friendly, while also promoting waste management and sustainability.

## Methods and Materials

The researcher will employ a Quantitative method and use Quasi-experimental design to harness organic by-products in developing eco briquettes. According to Pentang (2023) [5], quantitative research frequently involves using various instruments or tools to collect and analyze data. From a practical perspective, understanding quantitative instrumentation can improve the quality of research practice. Researchers can ensure that the data acquired is accurate and reliable in selecting appropriate instruments.

When internal validity threats are introduced from the absence of randomization, there are many challenges in designing and conducting quasi-experiment. Quasi-experiment are similar to randomized controlled trials in many respects. In conducting quasi-experimental evaluation, measurements, design and statistical issues must be considered as prior (Maciejewski, 2020) [4]. This design will be used since the purpose of this study is to harness organic by-products in developing eco briquettes.

## Conceptual Framework

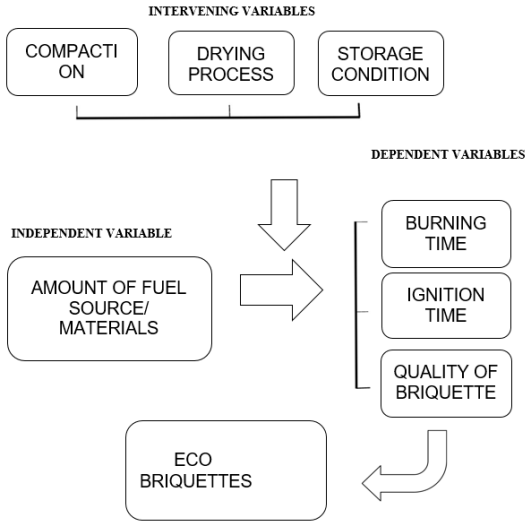


**Fig 1:** The Conceptual Framework of the Study wherein the input is the amount of fuel source/ materials. On the other side, the dependent variables consist of the following; burning time, ignition time, and quality of briquettes. Furthermore, the Intervening Variables are compaction pressure, drying process, and storage condition. The output in this study are eco briquettes

The Independent variable in this study is the amount of fuel source/ materials. In this study, the independent variable is the variable that can be manipulated. Furthermore, the dependent variables in this study are burning time, ignition time, and the quality of briquettes. Dependent variables can be measured and can be observed. Eco-briquettes is the output of this study.

## Results and Discussion

This chapter presents the results, the analysis, and interpretation of the gathered data. The main achievements are structured to demonstrate patterns and trends that address the research objectives. The results are discussed in detail in order to demonstrate the importance of each and its possible influence on subsequent research.

**Table 1:** Flammability Test

| briquettes | Material Type | Ignition Time (Seconds) | Burn Time (Seconds) | Char Length (cm) | Flame Spread Behavior | Self Extinguishing (Yes/No) | Dripping/ Melting (Yes/No) | Other Observations | Life SPAN (SECS) |
|---|---|---|---|---|---|---|---|---|---|
| **1st** | Coconut fiber, saw dust, ground coffee and dry leaves | 13.81 secs | 3661 secs | 40cm | Rapid spread | Yes | No | Quick Ignition | 3661 secs |
| **2nd** | Coconut fiber | 21.67 secs | 2893 secs | 40cm | Moderate spread | Yes | No | Charred and fully burnt | 2893 secs |
| **3rd** | Saw dust | 120 secs | 1349 secs | 40cm | Slow spread | Yes | No | Charred and fully burnt | 1349 secs |
| **4th** | Ground coffee | 50.87 secs | 1620 secs | 40cm | Moderate spread | Yes | No | Charred and fully burnt | 1620 secs |
| **5th** | Dry leaves | 41.26 secs | 3265 secs | 40cm | Rapid spread | Yes | No | Charred and fully burnt | 3265 secs |

Table 1 results indicated a variety of outcomes based on the material type. For the first briquette made from coconut fiber, sawdust, ground coffee, and dry leaves, ignition occurred quickly at 13.81 seconds, with a long burn time of 3661 seconds and rapid flame spread. The briquette self-extinguished and did not drip or melt. The second briquette, composed of coconut fiber alone, took 21.67 seconds to ignite, burning for 2893 seconds with a moderate flame spread. This briquette also self-extinguished and did not drip or melt. The third briquette made from sawdust showed a much slower ignition time of 120 seconds, with a burn time of 1349 seconds, slow flame spread, and similar characteristics of self-extinguishing with no dripping or melting. The ground coffee briquette ignited in 50.87 seconds and burned for 1620 seconds with moderate spread, also self-extinguishing without dripping. Lastly, the dry leaves briquette, which ignited in 41.26 seconds, showed rapid flame spread, a burn time of 3265 seconds, and exhibited similar behavior to the other briquettes with no dripping or melting. Throughout the tests, all briquettes self-extinguished without significant dripping or melting, and most showed charred and fully burnt residue.

**Table 2:** Water/ Solubility Test

| Briquettes | Material/ Substance | State (Solid/Powder/Liquid) | Amount Used | Reaction/ Behavior | Dissolved Completely (Yes/No) | Time to Dissolve (Seconds | Additional Observations |
|---|---|---|---|---|---|---|---|
| **1st** | Coconut fiber, saw dust, ground coffee and dry leaves | Solid | 30ml each | Float | No | 60 secs. | The water changed color, smell like coffee |
| **2nd** | Coconut fiber | Solid | 60ml | Float | No | 60 secs. | The water changed color, smell like coffee |
| **3rd** | Saw dust | Solid | 60ml | Float | No | 60 secs. | The water changed color, smell like coffee |
| **4th** | Ground coffee | Solid | 60ml | Float | No | 60 secs. | The water changed color, smell like coffee |
| **5th** | Dry leaves | Solid | 60ml | Float | No | 60 secs. | The water is clear |

Table 2 shows the water test analyzed how each briquette reacted to water, revealing that all floated and showed no dissolution within 60 seconds, even with stirring. Coconut fiber and ground coffee briquettes changed the water's color and odor, indicating possible leaching of materials, while dry leaves briquettes kept the water clear. The floating behavior and resistance to dissolution suggest these briquettes are relatively stable when exposed to moisture, a desirable trait for fuel storage. However, the 60-second stirring limit may not capture potential long-term water exposure effects, warranting extended tests to further evaluate their water resistance.

**Table 3:** Biodegradability Test

| Briquettes | Material | Initial Weight (g) | Initial Dimensions (cm) | Days in Soil/Compost | Weight After | Dimensions Change (cm) | Visual Changes | Breakdown Level (Low/Medium/High) | Additional Notes |
|---|---|---|---|---|---|---|---|---|---|
| **1st** | Coconut fiber, saw dust, ground coffee and dry leaves | 50g | 30cm | 3 days | 40g | 25cm | Partially broken down | Low | Microbial activity observed |
| **2nd** | Coconut fiber | 25 | 30cm | 3 days | 15g | 26cm | Partially broken down | Low | Microbial activity observed |
| **3rd** | Saw dust | 50g | 40cm | 3 days | 40g | 37cm | Partially broken down | Low | Microbial activity observed |
| **4th** | Ground coffee | 50g | 33cm | 3 days | 40g | 30cm | Partially broken down | Low | Microbial activity observed |
| **5th** | Dry leaves | 50g | 20cm | 3 days | 45g | 15cm | Partially broken down | Low | Microbial activity observed |

The Table 3 In the biodegradability test, the briquettes were buried in soil for three days to observe decomposition. All types showed partial breakdown with minor weight and dimension reductions, with coconut fiber-based briquettes shrinking the most, suggesting higher biodegradability. Microbial activity appeared as spots or discoloration, indicating some breakdown but rated as "Low" due to the short testing period. Although promising, the results suggest that a longer duration is necessary to understand the full biodegradability potential, particularly for denser materials like sawdust. This initial analysis underscores the need for prolonged testing to accurately assess the briquettes' environmental impact and suitability for sustainable energy.

## Conclusion

Eco-briquettes are a sustainable alternative to traditional fuels, helping reduce environmental waste and pollution while providing efficient energy. The ingredients of eco-briquettes like coconut fiber, coffee grounds, dried leaves, and sawdust are simple and easy to find, and making them is straightforward. Despite their simplicity, they offer a significant benefit to the environment and serve as an effective alternative to traditional charcoal. This aligns with the research by Borres and Espinosa (2022) [1], which found that briquettes made from biomass materials are effective and eco-friendly. Their study highlights the potential of these briquettes to reduce waste and provide sustainable energy solutions. Eco-briquettes are a sustainable and simple solution to environmental and energy problems. By using basic materials, eco-briquettes help reduce waste and minimize the reliance on traditional fuels like charcoal and wood, which contribute to deforestation and pollution. Their ease of production, accessibility of ingredients, and effectiveness demonstrate their great potential to meet the need for clean and affordable energy, especially in communities where access to electricity or conventional energy sources is limited. Additionally, they promote the adoption of renewable energy and align with the principles of a circular economy by turning waste into valuable resources.

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