



SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

REPLICATION OF DRYVE: ENCAPSULATED DRYING MACHINE FOR FASTER ORGANIC FERTILIZER DECOMPOSITION FOR RESIDENTIAL AREAS (2025)

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ABSTRACT

A drying machine offers an alternative to sun-drying, which can take months and is often hindered by unfavorable weather. However, existing drying machines are primarily designed for large-scale farms or industry. This study presented an improved small-scale drying machine suitable for residential areas. Through a series of experiments, the machine's performance and efficiency in drying organic waste were evaluated. The results show that the machine is durable and achieves an optimal drying time of up to 2 hours and 45 minutes at 110°C while consuming only 0.85 kilowatts per hour. Furthermore, thermal and airflow analyses showed uneven heat distribution by waste type, resulting in varying moisture content removal across the different layers of the drying rack. Specifically, a temperature of 110°C achieved moisture content removals of 16-64%, 53-88%, 56-94%, 45-86%, 91- 97%, and 88-96%, respectively. In general, this innovative small-scale drying machine enables residents to efficiently dry organic waste and produce their own fertilizers, enhancing fruit and vegetable yields, and promoting sustainable waste management practices.

KEYWORDS - Dryve, environmental waste, drying machine, mechatronics, residential unit

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I. Introduction

Household food waste (HFW) poses a major global sustainability issue, hindering progress towards development. Globally, around 931 million tons of food are wasted each year, with consumers playing a substantial role in it. Additionally, the common causes of HFW include overproduction, excessive purchasing, poor meal planning, and misunderstandings about expiration labels, all of which contribute to waste throughout the food supply chain. Tackling HFW is vital to combat hunger, mitigate climate change, ensure food security, and conserve resources, promoting sustainability and improving quality of life (Hinson et al. 2025).

Dehydration has been widely used in both the food industry and agriculture. According to O'Connor et al. (2021), dehydration is a process in which the water components of a particular food or food waste have been evaporated to form a product that has a low moisture content. This technique is often used for managing food waste by converting it to organic fertilizers. This promotes sustainable agricultural practices by recycling nutrients, reducing reliance on synthetic fertilizers, and conditioning soils (O'Connor et al., 2024).

A previous study by Abalus et al. (2025) developed the Dryve: Encapsulated Drying Machine for Faster Organic Fertilizer Decomposition to address the slow drying rates of organic waste. While the prototype proved effective, its design still had areas for improvement in terms of user safety, energy efficiency, mobility, and heat distribution. Gholami et al. (2021) and Obi et al. (2023) emphasize that product design directly impacts user efficiency, productivity, and safety, making targeted enhancements crucial for widespread adoption.

By addressing both technical and usability gaps in the original prototype, this study seeks to contribute to sustainable waste management and promote the circular use of food waste in residential settings. Danda (2023) found that the adoption of advanced agricultural machinery and technologies significantly enhanced farm production efficiency by improving mechanization quality, optimizing resource use, and accelerating productivity growth, thereby contributing to sustainable agricultural development. Ultimately, these improvements aim to reduce the disposal of organic waste, support soil health, and encourage eco-friendly farming practices.



Statement of the Problem

This study aimed to replicate and enhance the functionality of the Encapsulated Drying Machine for faster Organic Fertilizer Decomposition for Residential Areas (Dryve).

Specifically, the study sought to address the following questions:

1.) How does the drying machine perform in terms of:

1.1. safety of materials:

1.1.1. without breaker,

1.1.2. with breaker,

1.2. durability of materials,

1.3. efficiency and drying speed, and

1.4. moisture content?

2.) How efficient is the drying machine in terms of:

2.1. energy consumption using;

2.1.1. insulator foam sheet,

2.1.2. fiberglass insulator,

2.2. mobility;

2.2.1. without wheels,

2.2.2. with wheels, and

2.3. heat distribution?

3.) Based on the results of the study, what conclusions can be drawn?

Scope and Limitation

This study is a replication and improvement of a previous research project that developed an electricity-based drying machine to reduce the traditional one-month drying period of organic waste fertilizers. Conducted at Camp Vicente Lim Integrated School in Calamba, Laguna, the study aims to enhance the machine's durability, efficiency, energy consumption, heat distribution, safety, and mobility through a series of trials. The improved design is limited to small-scale or household use and focuses on the machine's construction, functionality, drying time, and moisture reduction. It excludes commercial applications, solar drying methods, and analysis of fertilizer nutrient composition or long-term soil effects, emphasizing the practicality and effectiveness of the improved design for residential users instead.

II. METHODOLOGY

By comprehensively describing these elements, this chapter provides a transparent understanding of the scientific process and development followed throughout the research.

Conceptual Framework of the Study

This conceptual framework presents the functional flow of the enhanced encapsulated drying machine “Dryve,” detailing its design principles, operational systems, and the factors that influence its performance.

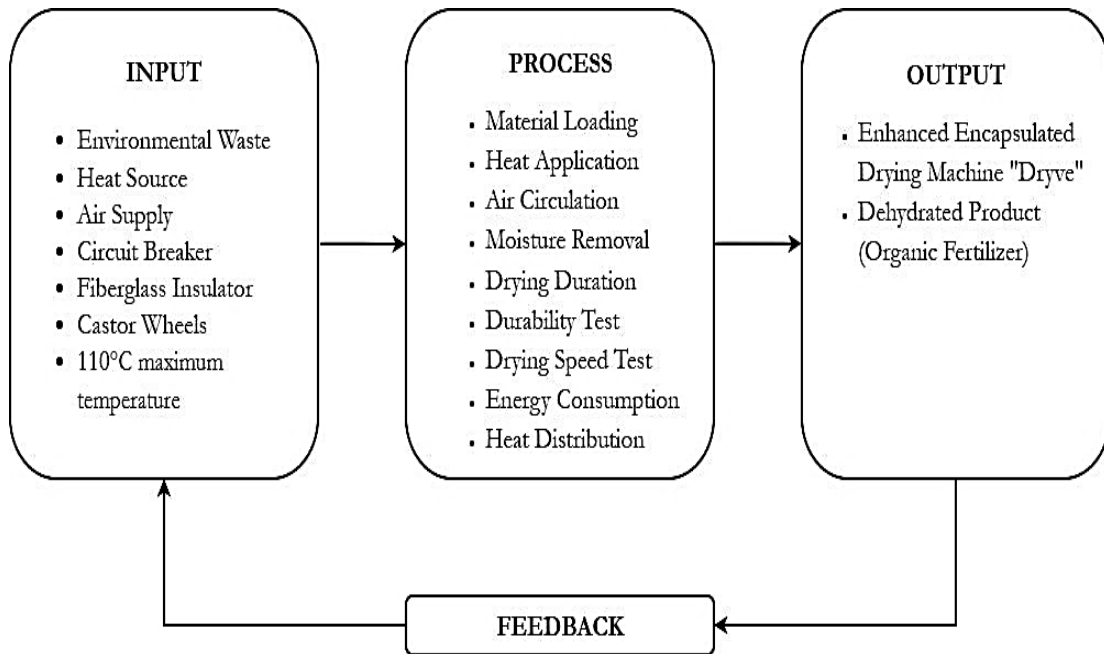


Figure 1. Input-Process-Output Method (IPO Method)

Figure 1 illustrates the Input–Process–Output (IPO) Model used in the study (Agus et al., 2020). The input includes the original materials, agricultural waste, a heat source, and air supply along with added components such as a circuit breaker for safety, a fiberglass insulator sheet for improved heat retention, and castor wheels for mobility. The process involves material loading, heat application, air circulation, moisture removal, and performance testing. The output is an enhanced encapsulated drying machine that produces dried organic material for high-quality organic fertilizer, with feedback used to refine the input and process stages.

Research Methodology Flowchart

Product Design

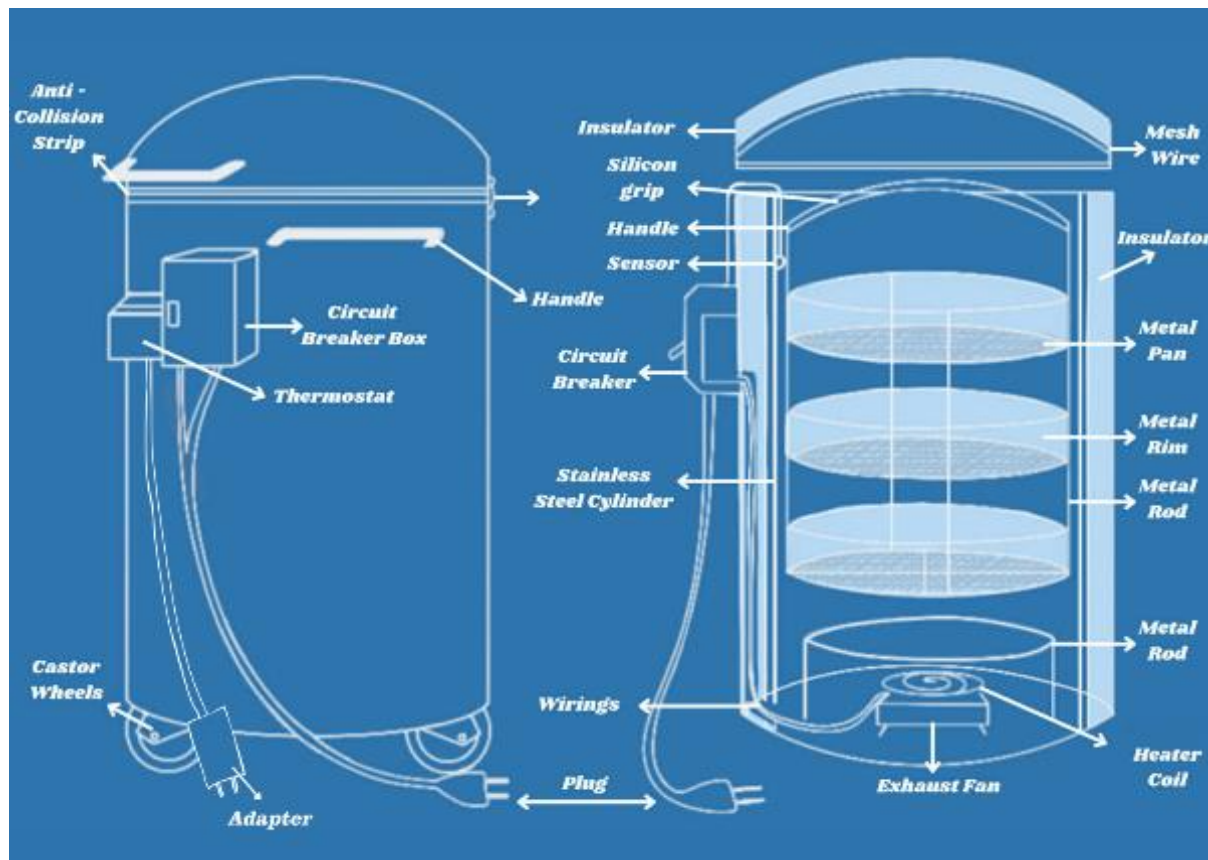


Figure 2 shows the blueprint of the encapsulated drying machine, featuring a cylindrical design measuring 16 inches in diameter and 25.4 inches in height. It includes key components such as a stainless-steel cylinder, internal trays, a sensor, a thermostat, a heating coil, an exhaust fan, and integrated wiring. The upgraded design incorporates fiberglass insulation for heat retention, a circuit breaker for safety, silicone-covered handles, and castor wheels for mobility. Together, these features enhance temperature control, heat distribution, moisture removal, energy efficiency, safety, and portability.

System Flowchart

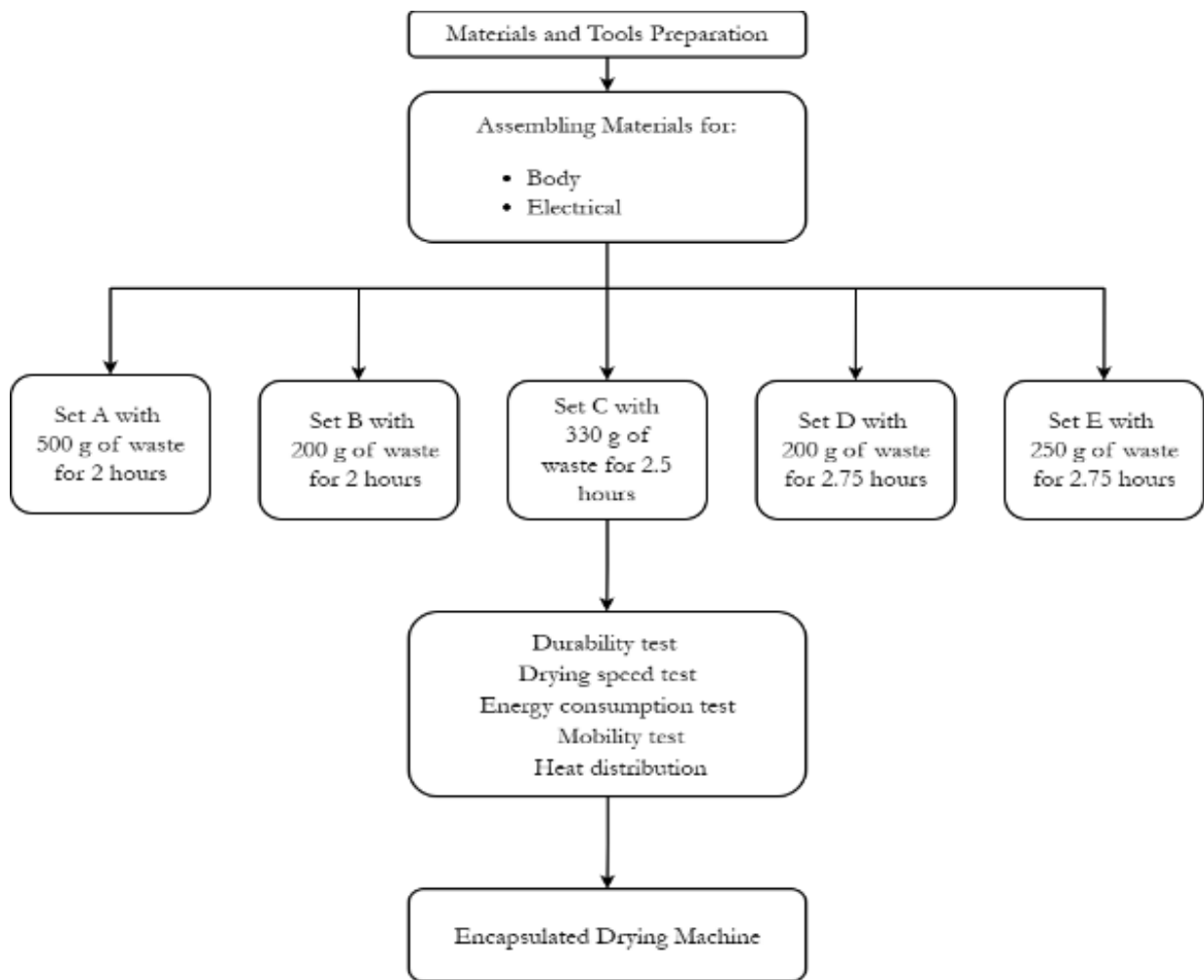


Figure 3. Flow Chart of the System

Figure 3 illustrates the flowchart of the research methodology. The first part is the preparation of all required materials and components, such as the pressure tank, heater coil, stainless steel sheet, thermostat, and insulating materials like foam sheet and fiberglass, together with the tools needed, including a welding machine, grinder, soldering equipment, and electrical devices. The second step focuses on assembling the different setups under varying amounts of the needed data. Third, the tests that were done include safety materials, durability test, efficiency and drying speed test, moisture content, energy consumption test, grip comfort, portability, and



heat distribution. Last is the encapsulated drying machine, which is the desired outcome of the study.

Table 1. Materials and Equipment

Quantity	Unit	Materials/Equipment
1	piece	Angle Bar
1	set	Castor Wheels
1	sheet	Fiberglass Insulator
2	cans	High-temp Spray Paint
1	sheet	Insulator Sheet
1	sheet	Mesh
1	piece	Metal Rod
1	sheet	Metal Sheet
1	piece	Miniature Circuit Breaker
2	bottles	Oily Glue
1	piece	Power Adapter
1	set	Rivets
5	meters	Silicone Tube
5	meters	Solid Wire
2	cans	Spray Paint
5	meters	Stranded Wire
1	piece	Sub Meter
1	piece	Thermostat
1	piece	Wire Sleeves

Table 1 presents the costs of the new materials used in constructing the encapsulated drying machine. Key components include a power adapter for electrical supply, angle bars and castor wheels for structural support and mobility, and fiberglass insulation with insulator sheets and mesh to prevent heat transfer and material exposure. High-temperature spray paint, metal rods, and metal sheets enhanced durability and protection, while a miniature circuit breaker improved electrical safety. Supporting materials such as oily glue, rivets, silicone tubing, solid and stranded wires, wire sleeves, a thermostat, and a sub-meter ensured proper assembly, temperature control,

user comfort, and accurate power consumption monitoring. Overall, primary materials accounted for the majority of the cost, while supporting materials contributed to the machine's durability, efficiency, and safety.

Treatment and General Procedures

This project centers on the design and development of an efficient organic waste drying machine. The process aims to produce a stable, durable, and well-structured system capable of effectively drying various organic materials.

Drying Racks

1. Prepare circular aluminum pans, about 12 inches in diameter, to serve as the base of each drying layer.
2. Fix metal rods on the sides of the racks to give them support and keep them steady.
3. Arrange the racks vertically, leaving enough gaps between each layer to allow good airflow and effective drying.
4. Make sure all racks are firmly in place, with proper spacing and strength to hold the organic materials.

Machine's Body

1. Make the Body
 - First, form the stainless-steel sheets into a tall cylinder (about 21 inches wide).
 - After that, attach four caster wheels under the cylinder so that the machine can be moved easily.
 - Next, install a hinged lid on top and attach a handle that is covered with a silicone grip for safe and comfortable use.
2. Install Trays and Support
 - First, place a cylindrical metal rod support at the bottom of the dryer close to the heating coil to support the drying racks.
 - Second, ensure that there is a space between each tray layer for hot air to pass through evenly.
3. Add Heating and Exhaust
 - Fix an improved heating coil made of copper at the lower part of the cylinder.
 - Then install the exhaust fan below it for proper airflow.
4. Apply Insulation
 - Firstly, line the inner wall with fiberglass insulation.
 - After that, secure it using mesh wire or a thin sheet.
5. Install Electrical Components
 - First, mount a casing/box on the outside of the machine.

- Upon doing that, place the circuit breaker and thermostat inside the casing.
- Next, pass the thermostat sensor inside the chamber.
- Finally, connect all wiring: plug → breaker → thermostat → heating coil + fan.

6. Final Setup

- First, check that the lid closes tightly.
- Second, plug in the machine and test if the heater warms up and the fan circulates air.
- Lastly, make sure the thermostat controls the temperature and the breaker trips for safety.

Electrical Wiring

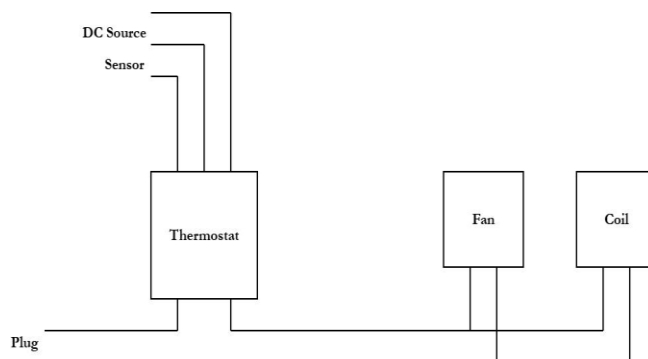


Figure 4. Electrical Diagram

The researchers used a block diagram to easily identify the connection of the parts of the device and to determine the parts that were used in the machine.

1. Five devices are used: circuit breaker, thermostat, exhaust fan, coil, and sensor.
2. The breaker is connected to the source.
3. To connect the coil and fan, there are two terminals in the breaker: the source and load.
4. The wires in the fan and coil are in a series connection going to the load of the thermostat.
5. The load is also supplied with 220v through the output of the breaker.
6. The thermostat has a power supply.
7. To open the thermostat, the power supply is connected to the DC source terminal.
8. Lastly, the sensor is series-connected to the thermostat.

Testing Process

The researchers' objective is to evaluate the effectiveness of the improved parameters of small-scale drying machines in accelerating the decomposition time and drying rate of waste fertilizer. Data collection for this study is conducted at Camp Vicente Lim Integrated School, Mayapa, Calamba City, Laguna. The structure and component designs are essential in the drying

process. With this, the researchers can assess the performance of the drying machine in terms of the following tests.

1. Durability test

An effective drying machine should be capable of completing the full drying process without sustaining damage. This principle is shown in design studies that emphasize durability through material selection and structural measures to withstand thermal stress during the drying process (Agberegha et al., 2023). To evaluate its durability, data were collected to identify any changes or signs of damage that occurred during repeated trials. Through this procedure, the researchers ensured that the components of the drying machine remained in proper condition for optimal functionality.

2. Drying speed test

Organic wastes were similarly prepared and spread evenly on the racks of the drying machine so that they were uniformly exposed to heat and airflow. The researchers monitored visible moisture-evaporation speed, texture changes, and weight variations before and after each trial.

3. Energy consumption test

The energy efficiency of the improved machine was tested by operating it under the upgraded conditions. The drying machine used fiberglass insulation with a density of 14.67 kg/m^3 , which falls within acceptable standards (Stephenus et al., n.d.). Energy consumption was measured in kilowatt-hours (kWh) during each drying cycle under varying airflow and temperature conditions. Previous studies indicate that higher air humidity increases energy consumption, while higher drying temperatures improve evaporation rates and reduce energy use (Yin et al., 2022; Kocabay et al., 2024). This test aimed to identify the insulation setup that provided better heat retention and lower electricity consumption. Energy usage was measured using a sub-meter, with consumption recorded over one hour, as kilowatt-hours are the standard unit for assessing electrical energy use.

4. Mobility test

An effective drying machine must have a lightweight design, compact structure, and durable yet easy-to-carry components. Product portability refers to a machine's ability to be easily and safely moved and used in different situations without increasing user effort. Incorporating portability enhances usability, flexibility, and overall user experience (Hwang et al., 2015).

According to Jayzmine (2024), castor wheels are critical for material handling equipment because they provide reliable mobility, reduce manual labor, and improve safety. These wheels adapt to challenging environments while delivering unmatched durability and performance.



These evaluations aim to assess the machine's efficiency in terms of mobility, user convenience, and operational stability, ensuring that portability does not negatively affect the overall drying performance. The mobility of the machine is perpendicular to the measured weight; the lower the weight, the higher the mobility, and if the mobility is increased, so does its portability (Del Pero et al., 2020).

5. Heat distribution

An effective drying machine must be capable of delivering uniform heat to ensure consistent drying (Asrate et al., 2025). To monitor heat distribution during operation, the researchers adjusted temperature settings to identify areas of uneven heating and to optimize the drying process, ensuring efficient energy consumption and consistent drying of organic waste. These evaluations were conducted to enhance the performance of small-scale drying machines. By analyzing these factors, the researchers improved both the design and operational efficiency of the machine, resulting in faster, more cost-effective, and sustainable drying of waste fertilizer.

Evaluation Procedure

Evaluation of the "Dryve" drying machine addressed various points, such as durability, rate of drying, utilization of energy, efficiency in size, and heat distribution. In an attempt at collecting data, the researchers observed the machine's performance descriptively, recorded numerical data in tables, and established its limit of operation under diverse scenarios.

Statistical tests may apply in the comparison of the findings from each of the trials in establishing significant differences in the performance. The procedure was that of facilitating the researchers in establishing the extent to which the machine is performing under various conditions. Finally, the assumptions in the design and the procedures in the test were investigated in establishing validity in the observations as well as the areas in which the enhancements are required.

Table 2. Experiment Set-Up

	Set A	Set B	Set C	Set D	Set E	Set F
Temperature	Drying Machine at 110°C	Drying Machine at 110°C	Drying Machine at 110°C	Drying Machine at 110°C	Drying Machine at 110°C	Drying Machine at 110°C
Watts	850 Watts	850 Watts	850 Watts	850 Watts	850 Watts	850 Watts
Weight	Organic Waste is 500 grams	Organic Waste is 200 grams	Organic Waste is 330 grams	Organic Waste is 330 grams	Organic Waste is 200 grams	Organic Waste is 250 grams
Time	Drying Machine running for 2 hours	Drying Machine running for 2 hours	Drying Machine running for 2.5 hours	Drying Machine running for 2.5 hours	Drying Machine running for 2.75 hours	Drying Machine running for 2.75 hours
Capacity	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space	Drying Racks is 1.5 kg of space

Table 2 presents the experimental set-ups used to evaluate the drying machine's performance, consisting of six runs labeled Set A to Set F. All set-ups were conducted at a constant drying temperature of 110 °C and a drying rack capacity of 1.5 kg to ensure controlled conditions. The mass of organic waste and operating time were systematically varied across the sets to examine their effects on drying performance. Overall, this design allowed a controlled comparison of the machine's efficiency under different load weights and drying durations.

Statistical Treatment

To calculate the moisture content loss of a material, the researchers utilized the moisture content formula on wet basis (Biswas et al., 2021).

$$MC_{wb} = \frac{W_i - W_f}{W_i} \times 100$$



Moisture Content Wet Basis

The researchers incorporated castor wheels to identify if the machine can be easily transferred from one place to another without compromising its stability and performance. To further compare the mobility, the following formulas will be used (Udegbumam, 2021).

$$F = mg$$

Gravitational Force acting on Mass

$$Fr = cW$$

Resistance due to Rolling Friction

Table 3. Costing

This part of the study showed the materials and ingredients used to make the product.

MATERIAL	COMPONENT ANALYSIS	PURPOSE
Angle Bar	PRICE: 400 php QUANTITY: 1 pc.	The angle bar will be welded together to serve as a frame for the wheels.
Castor Wheels	PRICE: 185 php QUANTITY: 1 set (4 pcs)	The castor wheels will be attached onto the frame under the machine for better mobility.
Fiberglass Insulator	PRICE: 5,290 php QUANTITY: 1 sheet.	The fiberglass insulator will act as a primary insulator inside the machine due to its high heat resistance rate.
High-temp Spray Paint	PRICE: 180 php QUANTITY: 2 pc.	The high-temp spray paint will be used as the first coat of the machine, preventing damage caused by heating while operating.
Insulator Sheet	PRICE: 180 php QUANTITY: 1 sheet	The insulator sheet will serve as a second layer insulator to ensure proper heat retention inside the chamber.
Mesh	PRICE: 280 php QUANTITY: 1 sheet	The mesh will be used to cover the exposed portions of the insulation.
Metal Rod	PRICE: 280 php QUANTITY: 1 pc	The metal rod will be welded together to form a frame for the drying racks, exhaust fan, heater coil, and handles.
Metal Sheet	PRICE: 350 php QUANTITY: 1 sheet	The metal sheet will act as the divider of the actual chamber from the insulation.
Miniature Circuit Breaker	PRICE: 250 php QUANTITY: 1 pc	The miniature circuit breaker will be installed, ensuring safety while operation by automatically switching off the system when a short circuit occurs.
Oily Glue	PRICE: 78 php QUANTITY: 1 pcs	The oily glue will act as an adhesive for the silicone tubes.
Power Adapter	PRICE: 40 php QUANTITY: 1 pc	The power adapter will be used to power the thermostat of the machine.
Rivets	PRICE: 56 php QUANTITY: 1 set	The rivets will be used so that the caster wheels could be attached on the frame under the chamber.
Silicone Tube	PRICE: 480 php QUANTITY: 5 meters	The silicone tubes will be used to protect the handles from heat and possible grounding; as well as an anti-collision strip for the lid of the machine.
Solid Wire	PRICE: 125 php QUANTITY: 5 meters	The solid wire will be used to connect the components of the machine inside the chamber because of its ability to resist high temperatures.
Spray Paint	PRICE: 280 php QUANTITY: 2 cans	The spray paint will be used a second coat to improve the machine's external appearance.
Stranded Wire	PRICE: 125 php QUANTITY: 5 meters	The stranded wires will serve as the primary wires of the machine to connect its parts.
Sub Meter	PRICE: 1,595 php QUANTITY: 1 pc	The sub meter will be used to accurately measure the kilowatts the machine is consuming in an hour.
Thermostat	PRICE: 521 php QUANTITY: 1 pc	The thermostat will serve as a medium to manipulate and monitor the temperature inside the machine.
Wire Sleeves	PRICE: 89 php QUANTITY: 1 pc	The wire sleeves will be used to protect the wires while also keeping the wiring system outside the machine neat.



The overall construction of the encapsulated drying machine's new materials consists of the power adapter, angle bar, castor wheels, fiberglass insulator, high-temp spray paint, insulator sheet, mesh, metal rod, metal sheet, miniature circuit breaker, oily glue, rivets, silicone tube, solid wire, spray paint, stranded wire, sub-meter, thermostat, and wire sleeve, with a total cost of Php 10,964.00. The primary materials contributed significantly to the overall cost, while the supporting materials ensured the durability and safety of the drying machine.

IV. Results

This chapter focuses on presenting, examining, and interpreting the data obtained from the experimental setups conducted. The findings are analyzed in line with the research objectives and existing literature to provide insights into the performance of the developed drying technology and identify potential areas for improvement.

Table 4. Durability Testing Results (table results from each trial and category)

Set Ups	Operating Time	Corrosion
Set A	2 hours	No Effect
Set B	2 hours	No Effect
Set C	2.5 hours	No Effect
Set D	2.5 hours	No Effect
Set E	2.75 hours	No Effect
Set F	2.75 hours	No Effect

Observations:

Table 4 shows that during the trial, the machine successfully operated for up to 5.5 hours without any signs of damage, malfunction, or performance degradation. The devices are still functional and intact. The results showed no signs of rusting, deterioration, or structural weakness, indicating that the materials used were resistant to corrosion. Periodic cleaning may still be necessary to prevent salt buildup.

Furthermore, the organic waste inside the machine remained unaffected, confirming that the internal drying process was not compromised. Overall, the test confirmed that the machine is durable and capable of withstanding moisture and salt exposure without affecting its normal operation.

Table 5. Efficiency and Drying Speed Test

	Set A	Set B	Set C	Set D	Set E	Set F
Duration	2 hours	2 hours	2.5 hours	2.5 hours	2.75 hours	2.75 hours
Temperature	110°C	110°C	110°C	110°C	110°C	110°C
Weight	500 grams	200 grams	330 grams	330 grams	200 grams	250 grams

Observations:

Table 5 presents the drying duration and efficiency tests conducted at a constant temperature of 110 °C, with moisture condition monitored every 30 minutes and weight measured hourly. Results showed that shorter drying times and heavier loads (Sets A and B) led to slower and uneven moisture removal, primarily in the lower layers of the drying rack. Improved drying performance was observed as drying time increased and sample weight became more moderate, with Sets E and F demonstrating the most uniform drying and lowest remaining moisture across all rack layers. These findings are consistent with Tun et al. (2019), who emphasized that optimal drying efficiency is achieved through proper balance of drying time and load weight. Overall, Sets E and F achieved the highest drying efficiency, indicating that longer drying durations combined with moderate sample weights significantly enhance moisture removal at a constant temperature.

Table 6. Energy Consumption Test

Set-ups	Watts	Hours	Kilowatts per hour (kph)
Set A	850 watts	2 hours	1.7 kWh
Set B	850 watts	2 hours	1.75 kWh
Set C	850 watts	2.5 hours	2.125 kWh
Set D	850 watts	2.5 hours	2.125 kWh
Set E	850 watts	2.75 hours	2.3375 kWh
Set F	850 watts	2.75 hours	2.3375 kWh

Observations:

Table 6 presents the electrical power consumption of the drying machine across all experimental setups, with the machine operating at a constant power rating of 850 W. Because energy use depended on operating time, Sets A and B (2 hours) consumed 1.7 kWh, Sets C and D (2.5 hours) consumed 2.125 kWh, and Sets E and F (2.75 hours) recorded the highest consumption at 2.3375 kWh. Energy data were obtained using a sub-meter, which measured 0.85 kWh during one hour of continuous operation and was used to confirm the machine's power rating and calculate total energy consumption for each setup.

$$W = \text{kWh} \times 1000$$

Kilowatts to Watts

After obtaining the watts of the drying machine, it will be multiplied and divided again to be able to determine how much electrical power it is consuming, or its kilowatts per hour. The consumed kilowatts per set was obtained by using this formula.

$$\text{kWh} = \frac{W \times t}{1000}$$

Kilowatts consumed

Table 7. Heat Distribution and Moisture Percentage

	Layer	Actual Weight	Dried Weight	Percent
Set A	1	500 g	420 g	16%
	2	500 g	355 g	29%
	3	500 g	180 g	64%
Set B	1	200 g	95 g	53%
	2	200 g	45 g	78%
	3	200 g	25 g	88%
Set C	1	330 g	144 g	56%
	2	330 g	72 g	78%
	3	330 g	20 g	94%
Set D	1	330 g	185 g	44%
	2	330 g	75 g	77%
	3	330 g	45 g	86%
Set E	1	200 g	18 g	91%
	2	200 g	12 g	94%
	3	200 g	6 g	97%
	1	250 g	30 g	88%
	2	250 g	22 g	91%
	3	250 g	10 g	96%

Observations:

Table 7 presents the heat distribution and moisture reduction across the different layers of the drying machine. Results show that drying efficiency improved progressively from Set A to Set E, with Set A exhibiting the lowest moisture reduction due to uneven heat distribution, particularly in the upper layers. Sets B, C, and D demonstrated moderate to high moisture removal, reflecting improved heat penetration, although some layer inconsistency remained. Set E recorded the highest and most uniform moisture reduction across all layers, indicating optimal heat distribution and drying conditions, followed closely by Set F. Overall, Set E proved to be the most efficient setup, while Set A showed the least efficiency and may require design or operational improvements.

Table 8. Safety Test

	Set A	Set B	Set C	Set D	Set E	Set F
Set Temperature (°C)	110°C	110°C	110°C	110°C	110°C	110°C
Thermostat Reading (°C)	110°C	110°C	110°C	110°C	110°C	110°C
Circuit Breaker Status	No Activation Observed	No Activation Observed	No Activation Observed	Activated (Single Occurrence)	No Activation Observed	No Activation Observed
Safety Remarks	Stable Operation	Stable Operation	Stable Operation	Automatic Safety Shutdown	Stable Operation	Stable Operation

Observations:

Table 8 shows that the circuit breaker was activated twice during initial testing due to high thermal load from the heating coil; however, these issues were resolved through system calibration before formal trials. During the official trials at a constant temperature of 110 °C, the thermostat maintained stable temperature control, and the circuit breaker activated only once, triggering an automatic safety shutdown. This response is consistent with the protective function of circuit breakers, which interrupt power during abnormal electrical conditions



(Alharbi et al., 2020). Overall, the results confirm that the safety mechanisms functioned effectively in preventing overheating and electrical hazards.

Table 9. Mobility Test

Normal Force	Resistance due to Rolling Friction
$F \approx 171.5 \text{ N}$	$Fr \approx 68.6 \text{ N}$

Observations:

Table 9 illustrates the distinction between the normal force, which is the force required to lift Dryve, and the resistive force due to rolling friction, which determines the force needed to move the machine along a horizontal axis once caster wheels are attached. The amount of energy lost as a result of friction rather than being transformed into movement of the equipment wheels is known as "resistance." Thus, the equipment uses more energy to move when there is less friction since less energy is absorbed. Given that the machine has a mass of 17.5 kg, more than 171.5 N of force is required to lift it. This is calculated using the gravitational force equation:

$$F = mg$$

Gravitational Force Acting on Mass

On the other hand, the resistive force due to rolling friction determines the force a person must exert to initiate horizontal motion when the machine is equipped with caster wheels. Using the standard rolling friction equation, which is relevant to the caster wheel industry, where c is the coefficient of rolling friction and W is the weight, the researchers found that approximately 68.6 N of force is required to push or pull the equipment (Udegbumam, 2021).

$$Fr = cW$$

Resistance due to Rolling Friction

The substantial difference between these forces highlights the importance of caster wheels in significantly reducing the effort required to transport the machine.

IV. DISCUSSION

Based on the findings of the study, the Dryve drying machine demonstrated satisfactory performance across key parameters, including durability, efficiency, energy consumption, heat distribution, safety, and mobility. The machine showed no signs of damage across all experimental trials, confirming its durability under extended operating conditions.

Furthermore, results further indicated that optimal combinations of drying time and sample weight, particularly in Sets D and E, significantly improved drying efficiency and moisture reduction at a constant temperature of 110 °C. While energy consumption increased proportionally with longer operating durations, the machine maintained a consistent power rating, supporting its energy-efficient design. Heat distribution and moisture analysis revealed Set E as the most effective configuration, whereas safety evaluations confirmed the reliable operation of the thermostat and circuit breaker in preventing overheating and electrical hazards.

The integration of fiberglass insulation, a thermostat, a circuit breaker, and castor wheels enhanced the machine's overall functionality, safety, and mobility. Overall, the Dryve drying machine is proven to be a practical and efficient solution for faster organic fertilizer drying in residential applications, though further improvements in airflow, heat distribution, moisture control, and wheel design may further enhance its sustainability and performance.



Image 1 Final Product of the Study



Recommendations

This study examined the performance and operational efficiency of drying machines in accelerating the drying process of agricultural waste materials, leading to several recommendations for improving efficiency, effectiveness, and safety in organic fertilizer decomposition. Design and operational enhancements include incorporating mesh into drying racks to prevent small, dried materials from falling through, installing an automated timer to ensure consistent drying without manual monitoring, and using copper heat coils to improve heat transfer and temperature stability. Designing removable racks is also recommended to facilitate easier loading, cleaning, and maintenance, while adding a moisture-absorbing component may help reduce internal humidity and further enhance drying efficiency. In terms of energy efficiency and cost reduction, regular cleaning of heater coils, fans, and filters is advised to maintain optimal performance and prevent efficiency losses caused by dust accumulation. Additionally, integrating solar panels as a supplementary or alternative power source may significantly reduce energy consumption and operational costs, contributing to a more sustainable drying system.

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