GROWTH AND YIELD PERFORMANCE OF WHITE OYSTER MUSHROOMS (*Pleurotus ostreatus*) WITH VARIOUS WOOD SAWDUST AND RICE STRAW SUBSTRATE COMBINATIONS

AN UNDERGRADUATE THESIS

Submitted to the Faculty
of the College of Agriculture and Forestry
Misamis University – Ozamis City
H.T. Feliciano St., Aguada, Ozamis City, Misamis Occidental

In Fulfillment
of the Requirements for the Degree
Bachelor of Science In Agricultural and Biosystems Engineering

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May 2026

CERTIFICATE OF PANEL APPROVAL

This research paper, entitled **"GROWTH AND YIELD PERFORMANCE OF WHITE OYSTER MUSHROOMS (*Pleurotus ostreatus*) WITH VARIOUS WOOD SAWDUST AND RICE STRAW SUBSTRATE COMBINATIONS"**, prepared and submitted by JAMIL M. MANGILA, JAMES ADRIAN N. ABIABI, in fulfillment of the requirements for the degree of **Bachelor of Science in Agricultural Biosystems Engineering,** has been examined and is recommended for acceptance and approval.

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ACKNOWLEDGEMENT

The completion of this works would not be possible without the support and assistance of the adviser, family, and classmates who patiently extend their helped in making this manuscript a possible one. As well as the Dutch naturalist Nikolaus Joseph von Jacquin and German mycologist Paul Kummer for naming the Pleurotus ostreatus

First and foremost, the researchers extend their deepest gratitude to their adviser, Gether P. Enario, for his continuous guidance, patience, and invaluable insights throughout the research process. His expertise, constructive feedback, and thoughtful recommendations greatly contributed to the improvement and completion of this study.

The researchers also acknowledge their fellow students and friends for their encouragement, cooperation, and willingness to share knowledge and ideas. Their support made the research journey more engaging, meaningful, and manageable.

Gratitude is also extended to the researchers' families for their unwavering support, understanding, and encouragement. Their motivation and sacrifices served as a strong foundation that inspired the researchers to persevere and achieve their goals.

Above all, heartfelt gratitude is offered to Almighty God for unwavering guidance, blessings, and grace, which led to the successful completion of this work.

Jamil

James Adrian

DEDICATION

This humble work is wholeheartedly dedicated to:

To our beloved families, whose unwavering love, endless support, and sacrifices have been our constant source of strength and inspiration;

To our esteemed mentors, whose wisdom, guidance, and encouragement have shaped our journey and enriched our learning;

And above all, to Almighty God, whose grace, guidance, and abundant blessings have sustained us and illuminated our path throughout this endeavor.

Thank you!

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ABSTRACT

This study addressed the limited utilization of locally available agricultural waste materials, particularly sawdust and rice straw, as alternative substrates for White oyster mushroom (*Pleurotus ostreatus*) production in Ozamiz City, where limited mushroom production and dependence on imported mushrooms remains a concern. The study into the topic using specifically Mahogany, Falcata and Gmelina are limited as of the release of the research paper. It evaluated the mycelial growth, yield performance, and economic viability of white oyster mushrooms (*Pleurotus ostreatus*) grown under different sawdust and rice straw substrate combinations. The experiment was conducted at R.S. Tan Village, Maningcol, Ozamiz City, Misamis Occidental, from September to December 2025. The study was laid out in a Randomized Complete Block Design (RCBD) with three replications using a factorial arrangement. Treatments consisted of three types of sawdust: A1 – Mahogany sawdust, A2 – Falcata sawdust, and A3 – Gmelina sawdust; and four substrate ratios: B1 – 70% sawdust + 30% rice straw, B2 – 60% sawdust + 40% rice straw, B3 – 50% sawdust + 50% rice straw, and B4 – 40% sawdust + 60% rice straw, giving twelve treatment combinations. Results showed that sawdust type significantly affected mycelial growth, mushroom count, yield performance, and economic returns, while substrate combinations showed no significant effect on most parameters. Gmelina sawdust (A3) consistently produced the highest mushroom count, yield, and return on investment, while Falcata sawdust (A2) exhibited the fastest mycelial growth rate. The findings suggest that Gmelina sawdust combined with rice straw can be effectively utilized as a sustainable and economically viable substrate for white oyster mushroom production.

Keywords: *economic analysis, falcata, gmelina, mahogany, mushroom yield, mycelial growth*

INTRODUCTION

<u>Background of the Study</u>

White oyster mushrooms are a type of fungus that is native to East Asia. They are named for their fan-shaped appearance, which resembles an oyster. These mushrooms are praised for their delicate flavor and versatile culinary application, oyster mushrooms are rich in protein, dietary fibre, essential amino acids and various vitamins and minerals. Moreover, these mushrooms are known for their potential to aid in cholesterol reduction and immune system enhancement (Jariall, 2023) Oyster mushrooms play a crucial role in sustainable agriculture, as they can be cultivated using various waste materials, such as agricultural residues like sawdust, reducing the strain on traditional farming resources. (Neeraj, 2023) The Philippines is a mega-biodiversity hot spot, which provides an ideal environment for growing a variety of agricultural products, including mushrooms. (Hyun, 2014)

Among the various mushroom cultivated, white oyster mushrooms (*Pleurotus ostreatus*) are particularly well-liked because of their ability to grow on a variety of substrates, including some inorganic materials as well as organic materials like wood, straw, and agricultural waste. Surprisingly, they can be found growing on unusual surfaces like cardboard, paper, and even trash in urban areas like homes, yards, and street corners. The increase in consumer needs and demand for healthy, quality organic products but the lack in mushroom production have led to a decline in the development of

the mushroom industry in the Philippines. (Domingo, 2025;Valverde, 2015). Supporting the mushroom industry is vital in developing the rural economy, enhancing employment and income opportunity in the rural communities as well as providing income to the small farmers. (Chand et al, 2022. ;Panganiban, 2014)

The mushroom industry in the Philippines has exacerbated since 1995, and the lowest production volume was 355 metric tons (M.T.) in 2009. Most of the mushrooms consumed were imported from different countries in Southeast Asia, such as China, Taiwan, Thailand, Malaysia, Korea, and Japan (Singh & Sharma, 2020.;Quirino, 2014). China, being the front-runner in mushroom production, has an industry characterized by high output, great cultivating variety, and diverse cultivation patterns (Xiong et al., 2020;Yu, 2008). This issue the decline tin the Mushroom inventory of the Philippines could be resolved through the advancement of the gap in knowledge between mushroom production practices in the Philippines as compared to the leading exporters In South East Asia for oyster mushrooms and oyster mushroom-related products. The effects of various common substrates on mycelial growth, colonization time, primordial appearance time, mushroom yield, biological efficiency (BE), size of the mushroom and chemical composition were analyzed. Among all aspects, rice straw was found as a best substrate with yield (381.85 gm) and BE (95.46%) %) followed by rice plus wheat straw, rice straw plus paper waste for the production of mushroom (Biswas et al., 2023. ;Sharma, 2013). Despite how common rice straw and waste is, there is an apparent lack in knowledge in how these wastes could be more efficiently utilized as a resource material.

There is a gap in the data of mushroom production in the Philppines despite the prevalence of agriculture waste that can be used as optimal substrate material for mushroom farming. Wheat straw showed promising results as a substrate with good pinhead formation, fruiting bodies, and yield (Abid, 2020). A combination of sawdust and teff straw yielded the highest bioconversion efficiency (Besufekad et al., 2020). Another study found that a mixture of sawdust, paddy straw, and cotton waste produced the best results in terms of primordia emergence, fruiting body weight, biological efficiency, and total yield (Gezahegn 2024;Liaqat et al., 2014). Sawdust alone performed well in spawn running and number of flushes (Khan et al., 2021;Liaqat et al., 2014). These findings suggest that while individual substrates like rice straw and wheat straw can be effective, combinations of different lignocellulosic materials may offer optimal conditions for oyster mushroom cultivation, potentially maximizing yield and growth rate. Usually, oyster mushroom can be grown on any nutritious media, taking from it the nutrients necessary for their growth.

These agri-waste materials that can be used as substrates are very inexpensive and can sometimes be obtained for free from agricultural sites, one of the merits of mushroom growing. Moreover, oyster mushrooms can be grown on a wider variety of agricultural wastes than any other cultivated mushrooms (Aloria, 2019). Examples of locally accessible wood substrates are Gmelina, Falcata and Mahogany. These woods' saw dust are commonly found in the local areas of the Philippines.Although a thought to take note is that Mahogany saw dust has a chemical compound that may make it unsuitable as a mushroom substrate despite it being an agricultural and industrial waste. It has low weight, with good drainage and is inexpensive (Yasin, 2020) making it the best choice substrates for the present research paper. The aim of objective of the study is to help mitigate the decline in the mushroom production industry and fill the gap in the mushroom production knowledge between the Philippines and the other leading Asian Mushroom importers.

Objectives of the Study

This study specifically aims to evaluate the growth and yield performance of white oyster mushrooms (*Pleurotus ostreatus*) using different substrates ratios of rice straw to various wood types. Specifically, the Gmelina, Falcata and Mahogany wood.

1. To determine the mycelial growth performance of the Oyster mushroom using different substrates ratios of various wood sawdust types to rice straw;
2. To evaluate the yield performance in terms of mushroom count of the white oyster mushrooms using different substrates ratios of various wood sawdust to rice straw;
3. To determine whether significant differences exist in the yield performance in terms of mushroom weight of white oyster mushroom across different substrate ratios of rice straw and various wood saw dust types; and
4. To identify the economic performance of the experiment.

Hypothesis of the Study

Null Hypothesis (Ho)

H1: There is no significant difference on the growth and yield performance of the white oyster mushrooms under various sawdust and rice straw substrate combinations.

Significance of the Study

This research serves to record whether or not there is an importance on what type of sawdust to use when farming white oyster mushrooms. It will hopefully prove that there is a significant difference in the wood-type that had more yield in a single harvest, in comparison to the wood-type that had the least amount of yield recorded. This should guide farmers to be more mindful of the cost of the wood-type they should use in order to maximize their profits from each yield. Researchers may use this study as a sample for when they choose to do a paper of their own and governments may use this paper as research material if a food-shortage of any kind may occur.

Scope and Limitations of the Study

The study was conducted in R.S Tan Village, Maningcol, Ozamiz with the weather limitations of Ozamiz City. The duration of the study was in the months of September until December. The study, which is an experiment, utilizes a 4 x factorial experiment arranged in a Randomized Complete Block Design (RCBD) with three replications. The research focuses on two main factors:

Factor A: the 3 types of sawdust and Factor B: the different ratios of Saw dust to Rice Straw. The substrates are limited to 10 polybags with 3 repetitions each. 12 treatments were done with 30 polybags per treatment. The study has several objectives: (1) To identify the growth and yield performance of the white oyster mushroom using different substrates ratios of various wood saw dust to rice straw. (2) To determine the significant differences in the growth and yield performance of white oyster mushroom across different substrate ratios of various wood saw dust to rice straw. (3) To find out which of the different ratios of substrates will give the highest growth rate and optimal yield.

Definitions of Terms

This section provides a comprehensive definition of specialized terminology and concepts, enabling the readers understand the specific terms used in the research.

Agri-waste - Agricultural Waste is unwanted or unsalable materials produced wholly from agricultural operations directly related to the growing of crops or raising of animals for the primary purpose of making a profit or for a livelihood. Some examples of agricultural waste include: Grape Vines. Fruit Bearing Trees.

Fruiting - Is a very delicate phase; it is necessary to maintain the environmental parameters stable in particular, to keep temperature and relative humidity within the ranges that allow the mycelium to develop primordia and bring them to maturity.

Fungus - A fungus is any member of the group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushroom.

Harvest - Is the process of collecting plants, animals, or fish (as well as fungi) as food, especially the process of gathering mature crops, and "the harvest" also refers to the collected crops. Reaping is the cutting of grain or pulses for harvest, typically using a scythe, sickle, or reaper.

Incubation - The maintenance of uniform conditions of temperature and humidity to ensure the development of eggs or, under laboratory conditions, of certain experimental organisms, especially bacteria.

Inoculation - Is the act of implanting a pathogen or other microbe or virus into a person or other organism. It is a method of artificially inducing immunity against various infectious diseases.

Mother Culture - Is the seed of mushroom. that is directly prepared from the pure. culture. It is usually grown on a grain.

Mushroom - A fleshy part of a fungus that bears spores, grows above ground, and consists usually of a stem bearing a flattened cap.

Mycelium - Is a root-like structure of a fungus consisting of a mass of branching, thread-like hyphae. Its normal form is that of branched, slender, entangled, anastomosing, hyaline threads. Fungal colonies composed of mycelium are found in and on soil and many other substrates.

Nutritious Media - A source of amino acids and nitrogen. This is an undefined medium because the amino acid source contains a variety of compounds with the exact composition being unknown.

Oyster Mushroom - A widely cultivated, edible fungus known for its fan-like shape and savory, umami flavor. Highly nutritious, it serves as an excellent meat substitute due to its meaty texture and rich protein and fiber content. In the wild, oyster mushrooms are primary decomposers of newly dead trees.

Rice Straw - Is produced as a byproduct of rice production at harvest. Rice straw is removed with the rice grains during harvest and it ends up being piled or spread out in the field depending if it was harvested manually or using machines.

Sawdust - Is a by-product or waste product of woodworking operations such as sawing, sanding, milling and routing. It is composed of very small chips of wood. These operations can be performed by woodworking machinery, portable power tools or by use of hand tools.

Substrate - Is the surface on which an organism lives. A substrate can include biotic or abiotic materials and animals.

MATERIALS AND METHODS

Time and Place of the Study

The experiment was conducted at R.S Tan Village, Maningcol, Ozamis City, Misamis Occidental, (figure 1) for the duration of 4 months, starting from September 20, 2025 and ending on December 13, 2026. The month of September was used to prepare the area for the experiment, as well preparation for the mother culture.

Figure 1. Map showing the location of the study area (source; Google Earth)

Legend:

A. Philippine map highlighting the province of Misamis Occidental
B. Aerial viewof the experimental site
C. Exact location of the sight as well as nearby landmarks

Preparation for the Procedure

The location where the experiment will take place is an unused piece of land measuring approximately 4x8 sqm that was modified to be able to fit the requirements of the research. (adding walls using a tarp, following proper sanitation practices and open ventilation.

Research Environment

The research environment was controlled and kept constantly moist to encourage the positive growth of the substrates. This was be achieved by spraying the polybags with water 3 (three) times a day. The facility is also enclosed which helps to keep the temperature of the facility cool and moist.

Materials

The materials were used in the study are 3 sacks of Mahogany, Falcata and Gmelina wood saw dust, 4 sacks of rice straw, a prepared white oyster mushroom mother culture, 360 Poly-bags, 360 0.5-inch 35mm-diameter PVC pipes, water sprayer, record book and pen, rubber bands, 3 bags or small scrap cloth or rags, 5 bags of molasses or brown sugar, and a steel drums.

Methods

Experimental Design and Treatments

The study used 3 replications. The factors of the study are the 3 types of sawdust (Factor A) and the 3 different ratios of Saw dust to Rice straw (Factor B). A total of 10 Polybags were used per replication or 30 Polybags per treatment equating to 360 Polybags in total. The types of sawdust (Factor A) include the following: A1 – Mahogany sawdust, A2 - Falcata sawdust, and A3 - Gmelina sawdust. For different ratios of Saw Dust to Rice Straw (Factor B), it includes B1 -70% SD + 30% RS, B2 - 60% SD + 40% RS, B3 - 50% SD + 50% RS, and B4 - 40% SD + 60% RS.

Experimental Layout

The study utilized 320 poly bags of white oyster mushroom for the 3 x 4 factorial experiment with three (3) replications in a Randomized Complete Block Design. Each block consisted of twelve (12) treatment combinations with ten (10) poly bags of white oyster mushroom per treatment (table 1).

Treatments, Treatment Combinations, and Treatment Codes

Table 2. Treatment, treatment combinations, and treatment codes of the study on the Optimizing Lettuce Yield through Exploring Hydroponic Solution Variations and Spacing Strategies

Different Sawdust (Factor A)	Ratio of Saw Dust to Rice Straw (Factor B)	Treatment Combinations	Treatment Code	Treatment #
A1 Mahogany Wood (MW)	B1 70%SD+30% RS	MW - 70% SD + 30% RS	A1B1	T1
	B2 60% SD+40% RS	MW - 60% SD + 40% RS	A1B2	T2
	B3 50% SD+50% RS	MW - 50% SD + 50% RS	A1B3	T3
	B4 40% SD+60% RS	MW - 40% SD + 60% RS	A1B4	T4
A2 Falcata Wood (FW)	B1 70% SD+30% RS	FW - 70% SD + 30% RS	A2B1	T5
	B2 60% SD+40% RS	FW - 60% SD + 40% RS	A2B2	T6
	B3 50% SD+50% RS	FW - 50% SD + 50% RS	A2B3	T7
	B4 40% SD+60% RS	FW - 40% SD + 60% RS	A2B4	T8
A3 Gmelina Wood (GW)	B1 70% SD+30% RS	GW - 70% SD + 30% RS	A3B1	T9
	B2 60% SD+40% RS	GW - 60% SD + 40% RS	A3B2	T10
	B3 50% SD+50% RS	GW - 50% SD + 50% RS	A3B3	T11
	B4 40% SD+60% RS	GW - 40% SD + 60% RS	A3B4	T12

Experiment Design

The experiment was conducted in an approximately 4x8 sqm in an enclosed area that has a space of 1m between each polybag row. This is optimal for the application of water easily between the rows. Each polybag will have 1cm of space between each bag.

This is to make sure that the polybags have room to grow comfortably without being excessively compacted between each other.

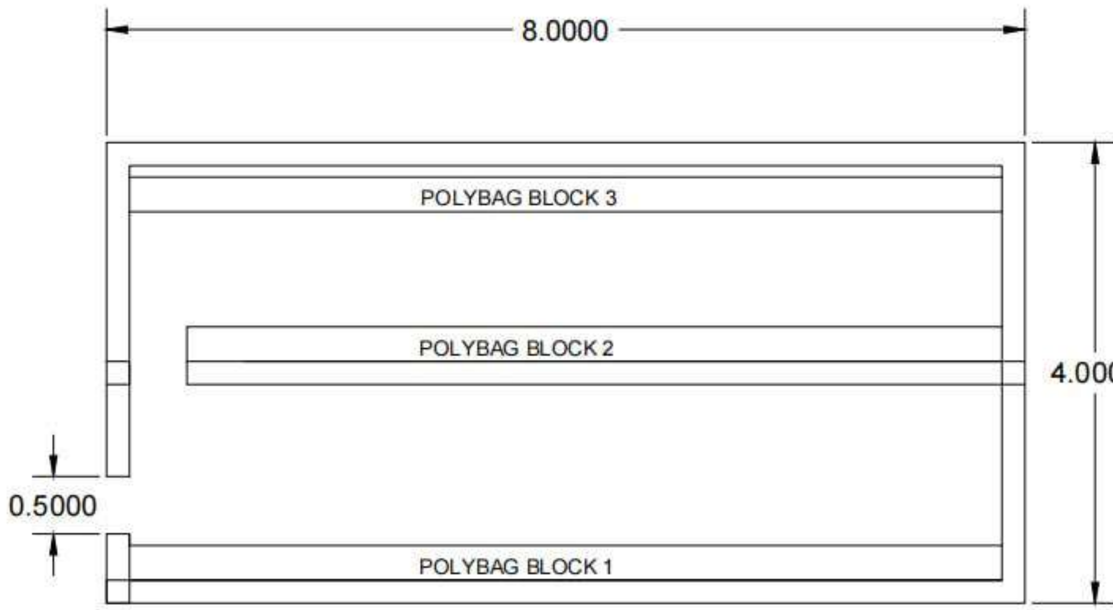

Figure 2. Schematic Diagram of the Experiment Facility

Experimental Procedure

The collection of materials includes: Gathering the rice straw, saw dust, molasses, white oyster mushroom spawn and the Polybags. These were bought at nearby farms, at a carpenter's saw mill, the market and ordered online. The researchers hung ropes of around 10 meters in length in several rows where the prepared poly-bags were tied. Planting spawn was purchased through an online store.

The rice straw were chopped manually until the strands are shorter and easier to utilize followed by soaking the chopped rice straw in clean water using large tubs for a minimum of 7 hours. Proceeded by washing the rice straw thoroughly then leaving it to air dry.

Preparation of Planting Spawn

Planting spawn was purchased online through a verified seller with years of experience in the field. Irresponsible sellers can sell planting spawn that may be infected with mold or diseases.

Mixing of Substrates and Bagging of Spawn Media

The substrates was divided 12 times to follow the 12 treatments that the researchers used. The researchers also used molasses in this process with at least 1% of the total ratios that the researchers divided. Using the purchased poly bags (measuring 6x12 inches and 0.03cm thick) the prepared spawning media is then added. A PVC pipe was then added at the entrance of the bag, tied with a rubber band and sealed with recycled cloth. The cloth served to minimize the entry of water during pasteurization and sterilization.

Pasteurization and Inoculation of the Sterilized Fruiting Bags

Sterilizing was done using a steel drum. The polybags were then steamed for 6-8 hours and left to cool. The polybags were then inoculated with the prepared white oyster Mushroom (*Pleurotus ostreatus*) and be left for the incubation process..

Incubation of the Sterilized Fruiting Bags

The fruiting bags were left to incubate in a dark and humid room for a total of 30 days or until the fruiting bags turn completely white. The researchers then record the progress of the mycelium growth once a week for the duration of the incubation.

Fruiting and Harvesting

Maintaining a room temperature of around 20-28 degrees, with low sunlight, and proper ventilation, the researchers will water the fruiting bags daily (2-3 times a day) to provide proper moisture for the bags. The grown mushrooms were then harvested by twisting gently at the base of the stem. The researchers also record the weight of the harvest for each of the different treatments in order to compare the yield performance of the treatments.

Pest Control

Pests such as roaches and ants could swarm and damage the bags during the incubation process. Because of this, the bags were checked daily and any dirt or leakage in the incubation area was immediately cleaned .

Disease Control

Whenever a polybag is infested with black mold during the incubation period, it is immediately seperated from the batch and thrown away to minimize damage as this could lead to further spreading of the mold. Several spare bags were prepared in advance to avoid a shortage of the bags used for the experiment.

Watering Schedule

During the spawning and harvesting period, the bags were misted 3 times daily. Once in the morning 9:00 am, once in the afternoon 12:00 pm and lastly 4:00 pm in the later afternoon.

Data Gathered

A. Rate of Mycellial Colonization (in.) – The Polybags were checked daily and recorded weekly after inoculation for the duration of exactly 1 month or 30 days. Parameters such as daily growth increment, weekly growth increment and the total growth increment to evaluate the efficiency between the treatments.

B. Number of Grown Mushrooms - The number of harvestable mushrooms were counted and harvested daily for the duration of 30 days. Parameters such as the total mushroom count, average weekly mushroom count and the average daily mushroom count to evaluate the efficiency between the treatment.

C. Weight of the Yield (g) – The weight of each daily harvest was measured, recorded and separated by treatment. The parameters recorded were the daily mushroom yield (g), weekly mushroom yield (g) and the total harvest (g) of each treatment for the total duration.

D. Economic Analysis - The economic analysis was conducted to evaluate the costeffectiveness and profitability if the experiment. The parameters included are the calculations for total production cost, grosssales, net income, and return on investment (ROI).

Statistical Analysis

The two-way Analysis of Variance (ANOVA) in Randomized Complete Block Design (RCBD) was used to test the significant difference of the yield performance among the treatments. A total of 12 different treatments with 3 repetitions for each was used and the data gathered after the first and following harvests were recorded. TUKEY's method (at 5% level of significance) was used to determine which of the different treatments vary significantly.

RESULTS AND DISCUSSION

Mycelial growth

Table 2 presents the mycelial growth of the mushroom across six weeks as influenced by different sawdust types and substrate combinations. For the main effect of sawdust type (Factor A), highly significant differences ($p \leq 0.01$) were observed in all observation periods and in both daily and weekly growth increments. Among the treatments, A3 (Gmelina) consistently exhibited the highest mycelial growth, reaching 12.00 cm at the 6th week, followed closely by A2 (Falcata) with 11.99 cm and A1 (Mahogany) with 11.86 cm. In terms of growth rate, A2 recorded the highest daily (0.25 cm) and weekly (1.77 cm) growth increments. These results suggest that the type of sawdust significantly influences mycelial colonization, likely due to differences in lignocellulosic composition, porosity, and nutrient availability. Substrates rich in cellulose and hemicellulose are known to promote faster fungal growth, as these components serve as primary energy sources for fungal metabolism (Diaz and Diaz-Godinez, 2022; Sánchez, 2010).

For substrate combinations (Factor B), no significant differences were observed during the 1st to 4th week, as well as in the 6th week, daily growth increment, and weekly growth increment. However, a highly significant effect ($p \leq 0.01$) was noted during the 5th week, where B4 (40% sawdust and 60% rice straw) recorded the highest growth (10.32 cm), followed by B2, B3, and B1. This indicates that substrate proportion had a limited effect on early and overall mycelial growth but may influence growth at specific stages of colonization. The temporary significance at the 5th week could be attributed to improved aeration and moisture retention in higher rice straw proportions, which are favorable for mycelial expansion (Sharma et al., 2025; Philippoussis et al., 2001).

Table 3. Recorded Mycelial Growth

TREATMENTS	Daily Growth Increment	Weekly Growth Increment
Different Sawdust		
A1	0.23	1.59
A2	0.25	1.77
A3	0.22	1.57
F-Test	0.000	0.000
Substrate Combination		
B1 -	0.23	1.63
B2	0.23	1.64
B3	0.23	1.63
B4	0.24	1.69
F-Test	0.311	0.107
A x B	0.236	0.149

A1 – Mahogany, A2 – Falcata, A3 – Gemilina, B1 – 70% sawdust & 30% rice straw, B2 – 60% sawdust & 40% rice straw, B3 - 50% sawdust & 50% rice straw, B4 – 40% sawdust & 60% rice straw

The interaction effect between sawdust type and substrate combination (A × B) showed highly significant differences ($p \leq 0.01$) during the 2nd to 5th weeks, but not in the 1st and 6th weeks, nor in the growth increment parameters. This implies that the combined effects of sawdust type and substrate ratio play an important role during the active colonization phase, particularly in the middle growth stages. The absence of interaction effects at the initial stage may be due to the adaptation phase of the mycelium, while the non-significance at the final stage suggests that most treatments reached near full colonization, minimizing variability. Similar findings have been reported where substrate composition significantly affects mycelial growth during intermediate stages but becomes less influential once the substrate is fully colonized (Suwannarach et al, 2022; Royse, 2002).

Mushroom count during harvest

Table 4 presents the mushroom count as influenced by different sawdust types and substrate combinations over a four-week harvesting period. For the main effect of sawdust (Factor A), highly significant differences ($p \leq 0.01$) were observed during the 1st week, total mushroom count, average weekly mushroom count, and average daily mushroom count, while a significant effect ($p \leq 0.05$) was noted during the 2nd week.

However, no significant differences were observed during the 3rd and 4th weeks. Among the treatments, A3 (Gmelina) recorded the highest total mushroom count (345.67), followed closely by A1 (Mahogany) with 341.92, while A2 (Falcata) had the lowest (308.00). Similarly, A3 obtained the highest average weekly (86.42) and daily mushroom count (12.35), indicating better productivity. The significant differences during the early stages suggest that substrate composition influenced initial fruiting performance, possibly due to variations in nutrient availability and substrate structure. Substrates with balanced lignin and cellulose content are known to support better fruiting body formation and yield in mushrooms (Klechak, 2025; Sánchez, 2010). The absence of significance in later weeks may indicate that the treatments eventually reached comparable production levels as nutrients became depleted or environmental conditions stabilized.

For substrate combinations (Factor B), no significant differences ($p > 0.05$) were observed across all weeks, total mushroom count, and average counts. Although slight numerical variations were noted, such as B1 (70% sawdust and 30% rice straw) having the highest total mushroom count (334.00), these differences were not statistically significant. This indicates that varying proportions of sawdust and rice straw did not substantially influence mushroom production. This finding suggests that all substrate combinations provided sufficient nutrients and physical support for fruiting, as long as the basic requirements for mushroom growth were met.

Table 4. Recorded Mushroom Yield in Count

TREATMENTS	Total Mushroom Count	Average Weekly mushroom count	Average Daily Mushroom count
Different Sawdust			
A1	341.92	85.48	12.21
A2	308.00	77.00	11.00
A3	345.67	86.42	12.35
F-Test	0.000	0.000	0.001
Substrate Combination			
B1	334.00	83.50	11.93
B2	330.11	82.53	11.79
B3	329.56	82.39	11.77
B4	333.78	83.44	11.92
F-Test	0.944	0.938	0.989
A x B	0.547	0.510	0.897

A1 – Mahogany, A2 – Falcata, A3 – Gemilina, B1 – 70% sawdust & 30% rice straw, B2 – 60% sawdust & 40% rice straw, B3 - 50% sawdust & 50% rice straw, B4 – 40% sawdust & 60% rice straw

Previous studies have shown that a wide range of lignocellulosic substrates can support mushroom production effectively, provided that moisture content, aeration, and nutrient balance are adequate (Suwannarach et al., 2022; Philippoussis et al., 2001). The interaction effect between sawdust type and substrate combination (A × B) was not significant ($p > 0.05$) across all parameters. This implies that the effect of sawdust type on mushroom count was independent of the substrate combination used. In other words, the performance of each sawdust type remained consistent regardless of the proportion of rice straw in the substrate. This lack of interaction suggests that sawdust type is the more dominant factor influencing mushroom production compared to substrate ratio. Similar observations have been reported in mushroom production studies where the primary substrate type plays a more critical role than substrate supplementation ratios in determining yield (Muleta et al., 2023; Royse, 2002).

Mushroom yield in weight

Table 5 shows the mushroom yield as affected by different sawdust types and substrate combinations over four weeks of harvesting. For the main effect of sawdust (Factor A), highly significant differences ($p \leq 0.01$) were observed during the 1st week, while significant differences ($p \leq 0.05$) were noted in the 2nd week, daily harvest, weekly harvest, and total harvest. However, no significant differences were found during the 3rd and 4th weeks. Among the treatments, A3 (Gmelina) consistently produced the highest yield, with a total harvest of 6725.42 g, followed by A1 (Mahogany) with 6444.17 g, and A2 (Falcata) with 5986.33 g. Similarly, A3 recorded the highest daily (240.19 g) and weekly harvest (1681.35 g). The significant differences observed, particularly in total yield, indicate that sawdust type plays an important role in determining mushroom productivity. This may be attributed to differences in chemical composition, such as lignin, cellulose, and nutrient content, which influence the efficiency of substrate utilization and fruiting body development. Substrates with favorable lignocellulosic balance are known to enhance mushroom yield by supporting better enzymatic degradation and nutrient absorption (Wang et al., 2023).

The absence of significant differences during the later weeks suggests that yield among treatments became comparable as the cropping period progressed. This may be due to the depletion of readily available nutrients in the substrate, resulting in a decline or stabilization of production across treatments. It is commonly observed that mushroom yield is highest during the initial flushes and gradually decreases in subsequent harvests due to reduced substrate quality (Seecharran et al, 2023).

For substrate combinations (Factor B), no significant differences ($p > 0.05$) were observed across all parameters, including weekly yields, daily harvest, weekly harvest, and total harvest. Although B4 (40% sawdust and 60% rice straw) showed the highest numerical total yield (6557.44 g), this was not statistically different from the other treatments. This indicates that varying the proportion of sawdust and rice straw did not significantly affect mushroom yield. The result suggests that all substrate combinations were able to provide adequate physical structure, aeration, and nutrient supply necessary for mushroom production. Previous studies have reported that a wide range of lignocellulosic materials can be used effectively as substrates, provided that environmental and nutritional requirements are satisfied (Kucharska et al, 2018).The interaction effect between sawdust type and substrate combination (A × B) was not significant across all parameters, indicating that the influence of sawdust type on yield was independent of the substrate ratio. This suggests that selecting the appropriate base material, such as Gmelina sawdust, is more critical than adjusting the proportion of rice straw in optimizing mushroom yield. Similar findings have been reported where the primary substrate component has a greater impact on yield than substrate mixtures or supplementation levels (Zhu, 2024).

Table 5. Recorded Mushroom Yield in Weight

TREATMENTS	Daily Harvest	Weekly Harvest	Total Harvest
Different Sawdust			
A1	230.15	230.15	230.15
A2	1611.04	1611.04	1611.04
A3	6444.17	6444.17	6444.17
F-Test	.017	.017	.017
Substrate Combination			
B1	227.79	1594.56	6378.22
B2	225.37	1577.56	6310.22
B3	224.83	1573.83	6295.33
B4	234.19	1639.36	6557.44
F-Test	.771	.771	.771
A x B	.833	.833	.833

A1 – Mahogany, A2 – Falcata, A3 – Gemilina, B1 – 70% sawdust & 30% rice straw, B2 – 60% sawdust & 40% rice straw, B3 - 50% sawdust & 50% rice straw, B4 – 40% sawdust & 60% rice straw

Economic Returns

Table 6 presents the economic performance of white oyster mushroom production as affected by different sawdust types and substrate combinations. For the main effect of sawdust (Factor A), highly significant differences ($p \leq 0.01$) were observed in gross sale per cycle, net income per cycle, and return on investment (ROI). Among the treatments, A3 (Gmelina) obtained the highest gross sale with ₱1304.73, followed by A1 (Mahogany) with ₱1250.17, while A2 (Falcata) recorded the lowest gross sale with ₱1161.35. Similarly, A3 achieved the highest net income of ₱1128.34 and the highest ROI of 639.69%, indicating superior economic performance compared to the other sawdust types. The significant differences observed suggest that sawdust type greatly influenced the profitability of mushroom production. This may be attributed to the higher mushroom yield and better production efficiency associated with Gmelina sawdust, which consequently increased marketable output and income generation. Substrate materials with favorable lignocellulosic composition are known to enhance biological efficiency and productivity, thereby improving the economic returns of mushroom cultivation.

The higher profitability recorded in A3 may also indicate that Gmelina sawdust provided more suitable physical and nutritional conditions for mushroom growth, resulting in increased production and reduced production losses. In contrast, the lower gross sale, net income, and ROI observed in A2 (Falcata) may be associated with lower productivity and less efficient substrate utilization. Economic returns in mushroom cultivation are closely related to yield performance since higher production directly contributes to increased market sales and profit margins.

For substrate combinations (Factor B), no significant differences ($p > 0.05$) were observed in gross sale, net income, and ROI. Although B4 (40% sawdust and 60% rice straw) recorded the highest numerical gross sale (₱1272.14), net income (₱1095.75), and ROI (621.21%), these values were not statistically different from the other substrate combinations. This result indicates that varying the proportion of sawdust and rice straw did not significantly affect the economic performance of mushroom production. The findings suggest that all substrate combinations were capable of supporting satisfactory mushroom productivity and profitability. Previous studies have shown that different substrate mixtures can provide comparable economic returns when they meet the nutritional and environmental requirements necessary for efficient mushroom cultivation.

The interaction effect between sawdust type and substrate combination (A × B) was not significant across all economic parameters, indicating that the profitability associated with sawdust type was independent of the substrate ratio used. This suggests that the choice of sawdust material had a greater influence on economic performance than the variation in rice straw proportion. Similar findings have been reported in mushroom production studies where the primary substrate component contributed more substantially to productivity and profitability than substrate formulation ratios or supplementation levels.

Table 6. Economic Returns of the Experiment

TREATMENTS	Gross Sale /cycle with 3% non-marketable Selling (₱200)	Net Income/Cycle	ROI% (cycle)
Different Sawdust			
A1	1250.17	1073.78	608.75
A2	1161.35	984.96	558.40
A3	1304.73	1128.34	639.69
F-Test	.017	.017	.017
Substrate Combination			
B1	1237.38	1060.99	601.50
B2	1224.18	1047.79	594.02
B3	1221.29	1044.90	592.38
B4	1272.14	1095.75	621.21
F-Test	.771	.771	.771
A x B	.833	.833	.833

A1 – Mahogany, A2 – Falcata, A3 – Gemilina, B1 – 70% sawdust & 30% rice straw, B2 – 60% sawdust & 40% rice straw, B3 - 50% sawdust & 50% rice straw, B4 – 40% sawdust & 60% rice straw

CONCLUSIONS AND RECOMMENDATIONS

Based from the results of the study, the following conclusions were drawn;

1. Sawdust type significantly influenced mycelial growth, with Gmelina (A3) and Falcata (A2) showing faster colonization rates compared to Mahogany (A1). Significant differences were observed across all growth periods, indicating that substrate composition plays a critical role in mycelial development. Substrate combinations had limited influence, although interaction effects were significant during the middle stages of colonization, suggesting that both substrate type and proportion affect growth during active mycelial expansion.

2. Mushroom count was significantly affected by sawdust type, particularly during the early stages and in total production. Gmelina (A3) and Mahogany (A1) produced higher mushroom counts compared to Falcata (A2). However, substrate combinations and their interaction with sawdust type did not significantly influence mushroom count, indicating that the base material is the primary factor affecting fruiting performance.

3. Mushroom yield was significantly influenced by sawdust type, with Gmelina (A3) producing the highest total yield, followed by Mahogany (A1) and Falcata (A2). Significant differences were observed in early harvests and overall yield, while substrate combinations and interaction effects showed no significant influence.

This indicates that the choice of sawdust is more critical than the proportion of rice straw in maximizing yield.

4. Economically, treatments using Gmelina (A3) provided higher productivity in terms of mushroom count and yield, which can translate to greater potential income. Although substrate combinations did not significantly affect production, they offer flexibility in formulation without negatively impacting output. Thus, profitability is mainly driven by the type of sawdust used rather than substrate proportion.

Based on the findings and conclusions of the study, the following recommendations are drawn;

1. Use Gmelina sawdust (A3) as the primary substrate material, as it consistently produced superior mycelial growth, mushroom count, and yield.
2. Falcata sawdust (A2) may be used as an alternative when rapid mycelial colonization is desired, although it may result in lower yield and mushroom production compared to Gmelina.
3. Substrate combinations of sawdust and rice straw can be adjusted based on availability of materials, since variations in proportion did not significantly affect growth, yield, or mushroom production.
4. Focus on optimizing substrate quality, particularly the type of sawdust, rather than emphasizing substrate ratios, to improve overall productivity.

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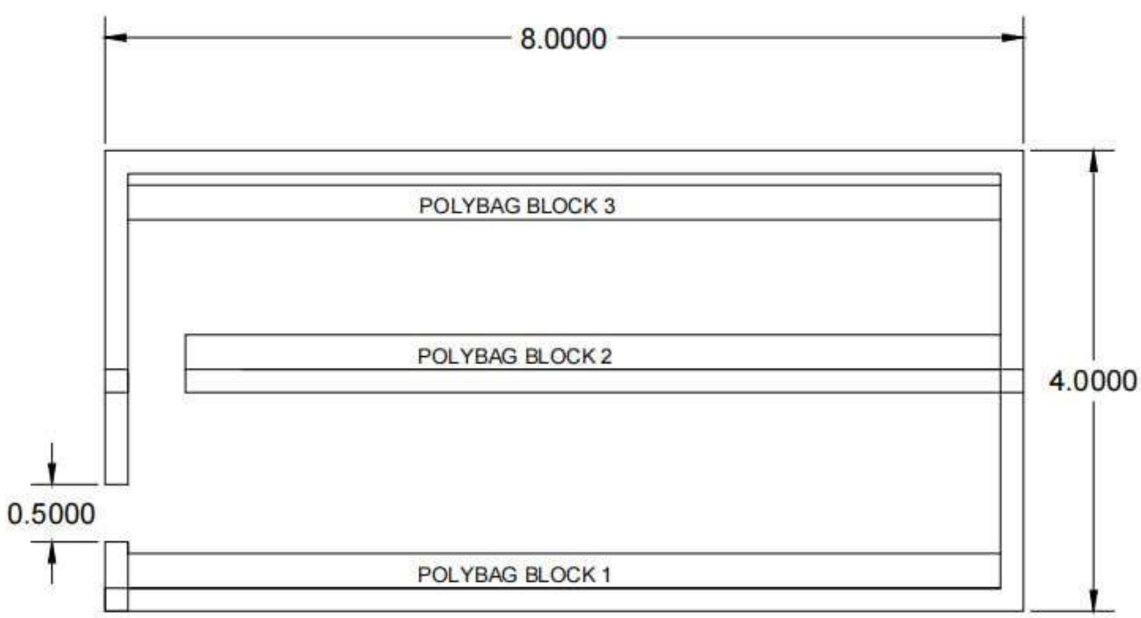
APPENDIX A

Figure 1. Map showing the location of the study area (source; Google Earth)

Figure 2. Schematic design of the experimental facility



APPENDIX B

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APPENDIX B - CONTINUED

Grammarly Results

APPENDIX C

Table 1. Experimental Layout

B1	B2	B3
T1	T7	T6
T3	T8	T9
T7	T3	T2
T10	T11	T1
T9	T9	T12
T2	T2	T10
T5	T12	T5
T6	T6	T8
T8	T10	T3
T11	T5	T7
T4	T4	T4
T12	T1	T11

Table 2. Treatment, treatment combinations, and treatment codes of the study on the Optimizing Lettuce Yield through Exploring Hydroponic Solution Variations and Spacing Strategies

Different Sawdust (Factor A)	Ratio of Saw Dust to Rice Straw (Factor B)	Treatment Combinations	Treatment Code	Treatment #
A1 Mahogany Wood (MW)	B1 70%SD+30% RS	MW - 70% SD + 30% RS	A1B1	T1
	B2 60% SD+40% RS	MW - 60% SD + 40% RS	A1B2	T2
	B3 50% SD+50% RS	MW - 50% SD + 50% RS	A1B3	T3
	B4 40% SD+60% RS	MW - 40% SD + 60% RS	A1B4	T4
A2 Falcata Wood (FW)	B1 70% SD+30% RS	FW - 70% SD + 30% RS	A2B1	T5
	B2 60% SD+40% RS	FW - 60% SD + 40% RS	A2B2	T6
	B3 50% SD+50% RS	FW - 50% SD + 50% RS	A2B3	T7
	B4 40% SD+60% RS	FW - 40% SD + 60% RS	A2B4	T8
A3 Gmelina Wood (GW)	B1 70% SD+30% RS	GW - 70% SD + 30% RS	A3B1	T9
	B2 60% SD+40% RS	GW - 60% SD + 40% RS	A3B2	T10
	B3 50% SD+50% RS	GW - 50% SD + 50% RS	A3B3	T11
	B4 40% SD+60% RS	GW - 40% SD + 60% RS	A3B4	T12

APPENDIX D

DATA RESULTS

Table 3. Recorded Mycelial Growth

TREATMENTS	Daily Growth Increment	Weekly Growth Increment
Different Sawdust		
A1	0.23	1.59
A2	0.25	1.77
A3	0.22	1.57
F-Test	0.000	0.000
Substrate Combination		
B1 -	0.23	1.63
B2	0.23	1.64
B3	0.23	1.63
B4	0.24	1.69
F-Test	0.311	0.107
A x B	0.236	0.149

A1 – Mahogany, A2 – Falcata, A3 – Gemilina, B1 – 70% sawdust & 30% rice straw, B2 – 60% sawdust & 40% rice straw, B3 - 50% sawdust & 50% rice straw, B4 – 40% sawdust & 60% rice straw

APPENDIX D - CONTINUED

Table 4. Recorded Mushroom Yield in Count

TREATMENTS	Total Mushroom Count	Average Weekly mushroom count	Average Daily Mushroom count
Different Sawdust			
A1	341.92	85.48	12.21
A2	308.00	77.00	11.00
A3	345.67	86.42	12.35
F-Test	0.000	0.000	0.001
Substrate Combination			
B1	334.00	83.50	11.93
B2	330.11	82.53	11.79
B3	329.56	82.39	11.77
B4	333.78	83.44	11.92
F-Test	0.944	0.938	0.989
A x B	0.547	0.510	0.897

A1 – Mahogany, A2 – Falcata, A3 – Gemilina, B1 – 70% sawdust & 30% rice straw, B2 – 60% sawdust & 40% rice straw, B3 - 50% sawdust & 50% rice straw, B4 – 40% sawdust & 60% rice straw

APPENDIX D - CONTINUED

Table 5. Recorded Mushroom Yield in Weight

TREATMENTS	Daily Harvst	Weekly Harvest	Total Harvest
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A3	6444.17	6444.17	6444.17
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Substrate Combination			
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B2	225.37	1577.56	6310.22
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B4	234.19	1639.36	6557.44
F-Test	.771	.771	.771
A x B	.833	.833	.833

A1 – Mahogany, A2 – Falcata, A3 – Gemilina, B1 – 70% sawdust & 30% rice straw, B2 – 60% sawdust & 40% rice straw, B3 - 50% sawdust & 50% rice straw, B4 – 40% sawdust & 60% rice straw

APPENDIX D - CONTINUED

Table 6. Economic Returns of the Experiment

TREATMENTS	Gross Sale /cycle with 3% non-marketable Selling (₱200)	Net Income/Cycle	ROI% (cycle)
Different Sawdust			
A1	1250.17	1073.78	608.75
A2	1161.35	984.96	558.40
A3	1304.73	1128.34	639.69
F-Test	.017	.017	.017
Substrate Combination			
B1	1237.38	1060.99	601.50
B2	1224.18	1047.79	594.02
B3	1221.29	1044.90	592.38
B4	1272.14	1095.75	621.21
F-Test	.771	.771	.771
A x B	.833	.833	.833

APPENDIX E

ANOVA TABLE RESULTS

Table 7. ANOVA table of the 1st week of mycelial growth

Tests of Between-Subjects Effects

Dependent Variable: MyceliumGrowth1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.565[a]	11	1.051	9.972	.000
Intercept	157.001	1	157.001	1489.180	.000
Sawdust	9.890	2	4.945	46.904	.000
SubstrateCombination	.666	3	.222	2.105	.126
Sawdust * SubstrateCombination	1.009	6	.168	1.595	.192
Error	2.530	24	.105		
Total	171.096	36			
Corrected Total	14.095	35			

a. R Squared = .820 (Adjusted R Squared = .738)

MyceliumGrowth1

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	1.35917	
Mahogany	12		2.33750
Gemilina	12		2.56833
Sig.		1.000	.211

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .105.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 8. ANOVA table of the 2nd week of mycelial growth

Tests of Between-Subjects Effects

Dependent Variable: MyceliumGrowth2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	17.978[a]	11	1.634	9.885	.000
Intercept	571.449	1	571.449	3456.055	.000
Sawdust	13.201	2	6.600	39.919	.000
SubstrateCombination	.311	3	.104	.627	.605
Sawdust * SubstrateCombination	4.466	6	.744	4.502	.003
Error	3.968	24	.165		
Total	593.396	36			
Corrected Total	21.946	35			

a. R Squared = .819 (Adjusted R Squared = .736)

MyceliumGrowth2

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2	Subset 3
Falcata	12	3.1650		
Mahogany	12		4.1775	
Gemilina	12			4.6100
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .165.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 9. ANOVA table of the 3rd week of mycelial growth

Tests of Between-Subjects Effects

Dependent Variable: MyceliumGrowth3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	27.180[a]	11	2.471	17.845	.000
Intercept	1251.626	1	1251.626	9039.371	.000
Sawdust	22.188	2	11.094	80.122	.000
SubstrateCombination	.792	3	.264	1.907	.155
Sawdust * SubstrateCombination	4.200	6	.700	5.055	.002
Error	3.323	24	.138		
Total	1282.130	36			
Corrected Total	30.503	35			

a. R Squared = .891 (Adjusted R Squared = .841)

MyceliumGrowth3

Tukey HSD[a,b]

Sawdust	N	Subset 1	2	3
Falcata	12	4.9675		
Mahogany	12		5.8342	
Gemilina	12			6.8875
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .138.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 10. ANOVA table of the 4th week of mycelial growth

Tests of Between-Subjects Effects

Dependent Variable: MyceliumGrowth4

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	39.205[a]	11	3.564	53.854	.000
Intercept	2340.463	1	2340.463	35364.815	.000
Sawdust	30.411	2	15.205	229.755	.000
SubstrateCombination	.192	3	.064	.965	.425
Sawdust * SubstrateCombination	8.603	6	1.434	21.665	.000
Error	1.588	24	.066		
Total	2381.257	36			
Corrected Total	40.793	35			

a. R Squared = .961 (Adjusted R Squared = .943)

MyceliumGrowth4

Tukey HSD[a,b]

Sawdust	N	Subset 1	2	3
Falcata	12	6.7833		
Mahogany	12		8.5058	
Gemilina	12			8.9000
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .066.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

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Table 11. ANOVA table of the 5th week of mycelial growth

Tests of Between-Subjects Effects

Dependent Variable: MyceliumGrowth5

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	58.749[a]	11	5.341	90.693	.000
Intercept	3688.538	1	3688.538	62635.547	.000
Sawdust	52.967	2	26.484	449.722	.000
SubstrateCombination	1.242	3	.414	7.031	.001
Sawdust * SubstrateCombination	4.539	6	.757	12.847	.000
Error	1.413	24	.059		
Total	3748.700	36			
Corrected Total	60.162	35			

a. R Squared = .977 (Adjusted R Squared = .966)

MyceliumGrowth5

Tukey HSD[a,b]

Sawdust	N	Subset 1	2	3
Falcata	12	8.5917		
Mahogany	12		10.2167	
Gemilina	12			11.5583
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .059.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 12. ANOVA table of the 6th week of mycelial growth

Tests of Between-Subjects Effects

Dependent Variable: MyceliumGrowth6

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.203[a]	11	.018	1.447	.216
Intercept	5140.890	1	5140.890	402330.522	.000
Sawdust	.152	2	.076	5.935	.008
SubstrateCombination	.023	3	.008	.609	.616
Sawdust * SubstrateCombination	.028	6	.005	.370	.891
Error	.307	24	.013		
Total	5141.400	36			
Corrected Total	.510	35			

a. R Squared = .399 (Adjusted R Squared = .123)

MyceliumGrowth6

Tukey HSD[a,b]

		Subset	
Sawdust	N	1	2
Mahogany	12	11.8583	
Falcata	12		11.9917
Gemilina	12		12.0000
Sig.		1.000	.982

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .013.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

Table 13. ANOVA table of the daily mycelial growth increment

Tests of Between-Subjects Effects

Dependent Variable: DailyGrowthIncrement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.007[a]	11	.001	6.808	.000
Intercept	1.998	1	1.998	19975.111	.000
Sawdust	.006	2	.003	31.194	.000
SubstrateCombination	.000	3	.000	1.259	.311
Sawdust * SubstrateCombination	.001	6	.000	1.454	.236
Error	.002	24	.000		
Total	2.007	36			
Corrected Total	.010	35			

a. R Squared = .757 (Adjusted R Squared = .646)

DailyGrowthIncrement

Tukey HSD[a,b]

Sawdust	N	Subset 1	2
Gemilina	12	.2258	
Mahogany	12	.2267	
Falcata	12		.2542
Sig.		.977	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .000.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 14. ANOVA table of the weekly mycelial growth increment

Tests of Between-Subjects Effects

Dependent Variable: WeeklyGrowthIncrement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.353[a]	11	.032	9.664	.000
Intercept	97.187	1	97.187	29302.534	.000
Sawdust	.295	2	.147	44.466	.000
SubstrateCombination	.022	3	.007	2.261	.107
Sawdust * SubstrateCombination	.035	6	.006	1.764	.149
Error	.080	24	.003		
Total	97.619	36			
Corrected Total	.432	35			

a. R Squared = .816 (Adjusted R Squared = .731)

WeeklyGrowthIncrement

Tukey HSD[a,b]

Sawdust	N	Subset 1	2
Gemilina	12	1.5725	
Mahogany	12	1.5858	
Falcata	12		1.7708
Sig.		.839	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .003.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

Table 15. ANOVA table of the 1st week of mushroom yield in count

Tests of Between-Subjects Effects

Dependent Variable: MushroomCount1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3138.306[a]	11	285.301	3.184	.009
Intercept	248170.028	1	248170.028	2769.411	.000
Sawdust	2576.222	2	1288.111	14.374	.000
SubstrateCombination	84.972	3	28.324	.316	.814
Sawdust * SubstrateCombination	477.111	6	79.519	.887	.519
Error	2150.667	24	89.611		
Total	253459.000	36			
Corrected Total	5288.972	35			

a. R Squared = .593 (Adjusted R Squared = .407)

MushroomCount1

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	71.0833	
Gemilina	12		88.4167
Mahogany	12		89.5833
Sig.		1.000	.951

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 89.611.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 16. ANOVA table of the 2nd week of mushroom yield in count

Tests of Between-Subjects Effects

Dependent Variable: MushroomCount2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1323.639[a]	11	120.331	.986	.485
Intercept	243213.361	1	243213.361	1993.552	.000
Sawdust	942.056	2	471.028	3.861	.035
SubstrateCombination	46.306	3	15.435	.127	.943
Sawdust * SubstrateCombination	335.278	6	55.880	.458	.832
Error	2928.000	24	122.000		
Total	247465.000	36			
Corrected Total	4251.639	35			

a. R Squared = .311 (Adjusted R Squared = -.004)

MushroomCount2

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	75.5000	
Mahogany	12	83.1667	83.1667
Gemilina	12		87.9167
Sig.		.226	.551

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 122.000.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 17. ANOVA table of the 3rd week of mushroom yield in count

Tests of Between-Subjects Effects

Dependent Variable: MushroomCount3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	554.750[a]	11	50.432	.685	.739
Intercept	235710.250	1	235710.250	3203.310	.000
Sawdust	60.167	2	30.083	.409	.669
SubstrateCombination	196.750	3	65.583	.891	.460
Sawdust * SubstrateCombination	297.833	6	49.639	.675	.671
Error	1766.000	24	73.583		
Total	238031.000	36			
Corrected Total	2320.750	35			

a. R Squared = .239 (Adjusted R Squared = -.110)

Table 18. ANOVA table of the 4th week of mushroom yield in count

Tests of Between-Subjects Effects

Dependent Variable: MushroomCount4

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	563.889[a]	11	51.263	.874	.576
Intercept	264538.778	1	264538.778	4511.320	.000
Sawdust	250.389	2	125.194	2.135	.140
SubstrateCombination	192.556	3	64.185	1.095	.371
Sawdust * SubstrateCombination	120.944	6	20.157	.344	.907
Error	1407.333	24	58.639		
Total	266510.000	36			
Corrected Total	1971.222	35			

a. R Squared = .286 (Adjusted R Squared = -.041)

APPENDIX E - CONTINUED

Table 19. ANOVA table of the total mushroom yield in count

Tests of Between-Subjects Effects

Dependent Variable: MushroomCountTotal

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12494.972[a]	11	1135.907	2.867	.015
Intercept	3964744.694	1	3964744.694	10008.471	.000
Sawdust	10332.722	2	5166.361	13.042	.000
SubstrateCombination	149.639	3	49.880	.126	.944
Sawdust * SubstrateCombination	2012.611	6	335.435	.847	.547
Error	9507.333	24	396.139		
Total	3986747.000	36			
Corrected Total	22002.306	35			

a. R Squared = .568 (Adjusted R Squared = .370)

MushroomCountTotal

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	308.0000	
Mahogany	12		341.9167
Gemilina	12		345.6667
Sig.		1.000	.890

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 396.139.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 20. ANOVA table of the average weekly mushroom yield in count

Tests of Between-Subjects Effects

Dependent Variable: MushroomCountWeekly

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	781.417[a]	11	71.038	2.864	.015
Intercept	248502.250	1	248502.250	10018.008	.000
Sawdust	637.167	2	318.583	12.843	.000
SubstrateCombination	10.083	3	3.361	.135	.938
Sawdust * SubstrateCombination	134.167	6	22.361	.901	.510
Error	595.333	24	24.806		
Total	249879.000	36			
Corrected Total	1376.750	35			

a. R Squared = .568 (Adjusted R Squared = .369)

MushroomCountWeekly

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	77.1667	
Mahogany	12		85.5000
Gemilina	12		86.5833
Sig.		1.000	.856

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 24.806.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 21. ANOVA table of the average daily mushroom yield in count

Tests of Between-Subjects Effects

Dependent Variable: MushroomCountDaily

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	14.083[a]	11	1.280	1.844	.102
Intercept	5112.250	1	5112.250	7361.640	.000
Sawdust	12.500	2	6.250	9.000	.001
SubstrateCombination	.083	3	.028	.040	.989
Sawdust * SubstrateCombination	1.500	6	.250	.360	.897
Error	16.667	24	.694		
Total	5143.000	36			
Corrected Total	30.750	35			

a. R Squared = .458 (Adjusted R Squared = .210)

MushroomCountDaily

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	11.0833	
Gemilina	12		12.3333
Mahogany	12		12.3333
Sig.		1.000	1.000

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = .694.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 22. ANOVA table of the 1st week of mushroom yield in weight

Tests of Between-Subjects Effects

Dependent Variable: Yield1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1646934.306[a]	11	149721.301	4.535	.001
Intercept	100383700.694	1	100383700.694	3040.625	.000
Sawdust	1525944.889	2	762972.444	23.110	.000
SubstrateCombination	49762.083	3	16587.361	.502	.684
Sawdust * SubstrateCombination	71227.333	6	11871.222	.360	.897
Error	792340.000	24	33014.167		
Total	102822975.000	36			
Corrected Total	2439274.306	35			

a. R Squared = .675 (Adjusted R Squared = .526)

Yield1

Tukey HSD[a,b]

Sawdust	N	Subset 1	2
Falcata	12	1378.7500	
Mahogany	12		1810.7500
Gemilina	12		1820.0833
Sig.		1.000	.991

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 33014.167.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 23. ANOVA table of the 2nd week of mushroom yield in weight

Tests of Between-Subjects Effects

Dependent Variable: Yield2

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	571112.083[a]	11	51919.280	1.177	.353
Intercept	86183372.250	1	86183372.250	1953.233	.000
Sawdust	399548.667	2	199774.333	4.528	.021
SubstrateCombination	37032.750	3	12344.250	.280	.839
Sawdust * SubstrateCombination	134530.667	6	22421.778	.508	.796
Error	1058962.667	24	44123.444		
Total	87813447.000	36			
Corrected Total	1630074.750	35			

a. R Squared = .350 (Adjusted R Squared = .053)

Yield2

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	1433.7500	
Mahogany	12	1520.4167	1520.4167
Gemilina	12		1687.5833
Sig.		.577	.147

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 44123.444.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 24. ANOVA table of the 3rd week of mushroom yield in weight

Tests of Between-Subjects Effects

Dependent Variable: Yield3

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	502636.306[a]	11	45694.210	.304	.978
Intercept	89129334.028	1	89129334.028	592.090	.000
Sawdust	167193.556	2	83596.778	.555	.581
SubstrateCombination	19714.306	3	6571.435	.044	.988
Sawdust * SubstrateCombination	315728.444	6	52621.407	.350	.903
Error	3612804.667	24	150533.528		
Total	93244775.000	36			
Corrected Total	4115440.972	35			

a. R Squared = .122 (Adjusted R Squared = -.280)

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Table 25. ANOVA table of the 4th week of mushroom yield in weight

Tests of Between-Subjects Effects

Dependent Variable: Yield4

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	295329.222[a]	11	26848.111	.787	.651
Intercept	91553002.778	1	91553002.778	2683.252	.000
Sawdust	23226.389	2	11613.194	.340	.715
SubstrateCombination	117483.889	3	39161.296	1.148	.350
Sawdust * SubstrateCombination	154618.944	6	25769.824	.755	.612
Error	818884.000	24	34120.167		
Total	92667216.000	36			
Corrected Total	1114213.222	35			

a. R Squared = .265 (Adjusted R Squared = -.072)

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Table 26. ANOVA table of the daily mushroom yield in weight

Tests of Between-Subjects Effects

Dependent Variable: YieldDaily

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5968.425[a]	11	542.584	1.229	.322
Intercept	1872194.719	1	1872194.719	4240.485	.000
Sawdust	4259.925	2	2129.963	4.824	.017
SubstrateCombination	498.333	3	166.111	.376	.771
Sawdust * SubstrateCombination	1210.167	6	201.695	.457	.833
Error	10596.116	24	441.505		
Total	1888759.261	36			
Corrected Total	16564.542	35			

a. R Squared = .360 (Adjusted R Squared = .067)

YieldDaily

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	213.7983	
Mahogany	12	230.1483	230.1483
Gemilina	12		240.1942
Sig.		.159	.481

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 441.505.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

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Table 27. ANOVA table of the weekly mushroom yield in weight

Tests of Between-Subjects Effects

Dependent Variable: YieldWeekly

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	292470.644[a]	11	26588.240	1.229	.322
Intercept	91737285.835	1	91737285.835	4240.171	.000
Sawdust	208739.274	2	104369.637	4.824	.017
SubstrateCombination	24420.644	3	8140.215	.376	.771
Sawdust * SubstrateCombination	59310.726	6	9885.121	.457	.833
Error	519246.708	24	21635.280		
Total	92549003.188	36			
Corrected Total	811717.352	35			

a. R Squared = .360 (Adjusted R Squared = .067)

YieldWeekly

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	1496.5833	
Mahogany	12	1611.0417	1611.0417
Gemilina	12		1681.3542
Sig.		.159	.481

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 21635.280.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

Table 28. ANOVA table of the total mushroom yield in weight

Tests of Between-Subjects Effects

Dependent Variable: TotalYield

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4679530.306[a]	11	425411.846	1.229	.322
Intercept	1467796573.361	1	1467796573.361	4240.171	.000
Sawdust	3339828.389	2	1669914.194	4.824	.017
SubstrateCombination	390730.306	3	130243.435	.376	.771
Sawdust * SubstrateCombination	948971.611	6	158161.935	.457	.833
Error	8307947.333	24	346164.472		
Total	1480784051.000	36			
Corrected Total	12987477.639	35			

a. R Squared = .360 (Adjusted R Squared = .067)

TotalYield

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	5986.3333	
Mahogany	12	6444.1667	6444.1667
Gemilina	12		6725.4167
Sig.		.159	.481

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 346164.472.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

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Table 29. ANOVA table of the total gross sale of the experiment

Tests of Between-Subjects Effects

Dependent Variable: GrossSale

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	176118.803[a]	11	16010.800	1.229	.322
Intercept	55241991.835	1	55241991.835	4240.171	.000
Sawdust	125697.781	2	62848.891	4.824	.017
SubstrateCombination	14705.526	3	4901.842	.376	.771
Sawdust * SubstrateCombination	35715.496	6	5952.583	.457	.833
Error	312677.906	24	13028.246		
Total	55730788.543	36			
Corrected Total	488796.708	35			

a. R Squared = .360 (Adjusted R Squared = .067)

GrossSale

Tukey HSD[a,b]

Sawdust	N	Subset	
		1	2
Falcata	12	1161.3487	
Mahogany	12	1250.1683	1250.1683
Gemilina	12		1304.7308
Sig.		.159	.481

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 13028.246.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 30. ANOVA table of the total net income of the experiment

Tests of Between-Subjects Effects

Dependent Variable: NetIncome

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	176118.803[a]	11	16010.800	1.229	.322
Intercept	40629860.463	1	40629860.463	3118.598	.000
Sawdust	125697.781	2	62848.891	4.824	.017
SubstrateCombination	14705.526	3	4901.842	.376	.771
Sawdust * SubstrateCombination	35715.496	6	5952.583	.457	.833
Error	312677.906	24	13028.246		
Total	41118657.171	36			
Corrected Total	488796.708	35			

a. R Squared = .360 (Adjusted R Squared = .067)

NetIncome

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	984.9587	
Mahogany	12	1073.7783	1073.7783
Gemilina	12		1128.3408
Sig.		.159	.481

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 13028.246.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX E - CONTINUED

Table 31. ANOVA table of the ROI of the experiment

Tests of Between-Subjects Effects

Dependent Variable: ROI

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	56604.576[a]	11	5145.871	1.229	.322
Intercept	13058647.006	1	13058647.006	3118.602	.000
Sawdust	40400.413	2	20200.206	4.824	.017
SubstrateCombination	4726.140	3	1575.380	.376	.771
Sawdust * SubstrateCombination	11478.024	6	1913.004	.457	.833
Error	100496.169	24	4187.340		
Total	13215747.751	36			
Corrected Total	157100.745	35			

a. R Squared = .360 (Adjusted R Squared = .067)

ROI

Tukey HSD[a,b]

Sawdust	N	Subset 1	Subset 2
Falcata	12	558.3983	
Mahogany	12	608.7533	608.7533
Gemilina	12		639.6858
Sig.		.159	.481

Means for groups in homogeneous subsets are displayed.

Based on observed means.

The error term is Mean Square(Error) = 4187.340.

a. Uses Harmonic Mean Sample Size = 12.000.

b. Alpha = 0.05.

APPENDIX F
DOCUMENTATION

Figure 3. Mushrooms During Pasteurization

APPENDIX F - CONTINUED

Figure 4. Average Mushroom Harvest During Recording

APPENDIX F - CONTINUED

Figure 5. Mushrooms During The Incubation Process

CURRICULUM VITAE

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Address: Kaangayan, Mahayag Zamboanga Del Sur

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Place of Birth: Ozamiz City, Misamis Occidental

Age: 23

Nationality: Filipino

PERSONAL PARTICULAR

Civil Status: Single

Religion: UCCP

Name of Parents: **Mother: Vergie M. Mangila**

Father: Rhommel R. Mangila

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Junior High School	:Western Mindanao Adventist Academy
	:Dumingag, Zamboanga Del Sur (2018-2019)
Senior High School	:Western Mindanao Adventist Academy
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Tertiary	: Misamis University
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	: Ozamiz City, Misamis Occidental (2018-2019)
Senior High School	: Ozamiz City School of Arts and Trades
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	: Ozamiz City, Misamis Occidental (2021 - 2026)