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EFFECT OF TEXTURAL ATTRIBUTES OF TREE SAWDUST SUBSTRATES ON *PLEUROTUS* OYSTER MUSHROOM PRODUCTION

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Abstract

Optimizing growth conditions for oyster mushrooms (*Pleurotus sajor-caju*) is crucial for enhancing their nutritional and economic value. Moreover, impact of different tree sawdust substrates on their productivity under climatic condition of Arakan, Cotabato, Philippines, remains underexplored. Hence, this study evaluated coconut, rubber, and gmelina sawdust substrates as organic media. Using a two-factor completely randomized design with three treatments and four replications, sawdust texture (Factor A) and tree substrates (Factor B) were assessed. Fine sawdust significantly improved growth parameters except for stalk length, with all tree substrates showing highly significant effects. The interaction of these factors yielded significant outcomes, except for the number of flushes and stalk length. Fine-textured sawdust, particularly from coconut and rubber trees, was optimal for enhancing mycelial length, reducing days to flush, increasing stalk length, cap circumference, fruit weight, and overall yield. Fine-textured sawdust from coconut and rubber reduced flushing time by 55.05% and increased flushes by 57.18%, resulting in the highest net revenues of 1970.45 and 1500.95 pesos, respectively. Conducted under temperatures averaging 29°C and 22°C, these findings highlight the importance of selecting appropriate sawdust texture and tree substrates to maximize *Pleurotus* productivity, providing valuable insights for mushroom producers to boost output and profitability.

Keywords: Agricultural Waste Utilization, Mycelial Growth, Oyster Mushroom Cultivation, *Pleurotus Sajor-Caju*, Sawdust Substrate.

INTRODUCTION

Mushroom cultivation is a significant agricultural practice, providing not only a nutritious food source but also generating income for farmers and reducing pressure on natural forests (Chang & Wasser, 2017; Prajapati et al., 2023; Thakur, 2020). Among the various types, oyster mushrooms are particularly popular due to their high yield, rapid growth rate, and substantial nutritional value (Aditya et al., 2024; Berry & Ray, 2023). A critical factor in oyster mushroom production is the substrate used, with tree sawdust being a widely favored choice due to its availability and low cost (Shah et al., 2024). Despite the growing popularity of tree sawdust as a substrate for oyster mushroom cultivation, there is a gap in understanding the optimal tree species and sawdust textures for maximizing yield and profitability. Previous research has highlighted the benefits of using sawdust substrates, such as promoting sustainable agricultural practices and addressing issues like hunger, poverty, and waste management (Jayaraman et al., 2024; Masarirambi et al., 2011). However, substrate nutritional content varies across different tree species, impacting mushroom growth and development.

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While some studies have investigated these variables (Karmani et al., 2022; Onyeka et al., 2018; Siwulski et al., 2019), the specific conditions for optimal growth in diverse climatic environments remain underexplored. High-quality oyster mushrooms have been successfully incubated under specific conditions. For instance, Dulay et al. (2021) demonstrated optimal growth with a pH of 6, darkness, and a temperature of 30°C in sealed conditions. This aligns with prior research (Chang et al., 2014), which underscores the preference of oyster mushrooms for cooler temperatures. However, despite the current high market demand, there is a notable absence of studies exploring temperature ranges beyond the conventional requirements. Conducting such research would provide valuable insights for mushroom growers, especially those interested in cultivating oyster mushrooms in high-humidity environments.

Barangay Naje in Arakan, Cotabato, offers a unique climate with an average high temperature of 84°F (29°C) and a low of 71°F (22°C) (Global Modeling and Assimilation Office [GMAO], 2015). Farming is the primary source of income for 75% of the population (Foundation of the Philippine Environment, 2024), making oyster mushroom cultivation a promising avenue for enhancing livelihoods. Given the need for additional income to sustain daily livelihoods, exploring optimal substrates for oyster cultivation is essential for meeting these economic and nutritional requirements.

This study aims to fill this gap by evaluating the impact of different tree sawdust substrates—specifically coconut, rubber, and gmelina—on the growth and yield of oyster mushrooms (Pleurotus sajor-caju). It employs a two-factor completely randomized design to assess the effects of sawdust texture and tree species on mushroom productivity. The findings aim to identify the best substrate compositions to maximize yield and return on investment, thereby contributing to increased food production and reduced waste. These insights provide valuable guidance for mushroom producers aiming to boost output and profitability in warm, humid environments like Barangay Naje.

MATERIALS AND METHODS

This study was conducted in Barangay Naje, Arakan, Cotabato, from February 2022 to March 2023, with the objective of investigating the impact of various tree sawdust substrates on the growth and yield of oyster mushroom production. The experimental design employed was a two-factor completely randomized design (CRD). Factor A represented the texture of the sawdust, while Factor B encompassed the different sources of tree substrates. Each factor was tested across three treatments, with four replications per treatment. In total, the study involved 480 bags, each weighing 600 grams.

These bags were vertically suspended within a 60-square-meter Mushroom House, where the planting and incubation procedures were meticulously carried out. Each treatment consisted of 20 bags, ensuring robust data collection for statistical analysis. The study's rigorous design and comprehensive approach aimed to provide valuable insights into optimizing oyster mushroom cultivation through the use of different sawdust substrates, ultimately contributing to enhanced agricultural practices and economic sustainability in the region.

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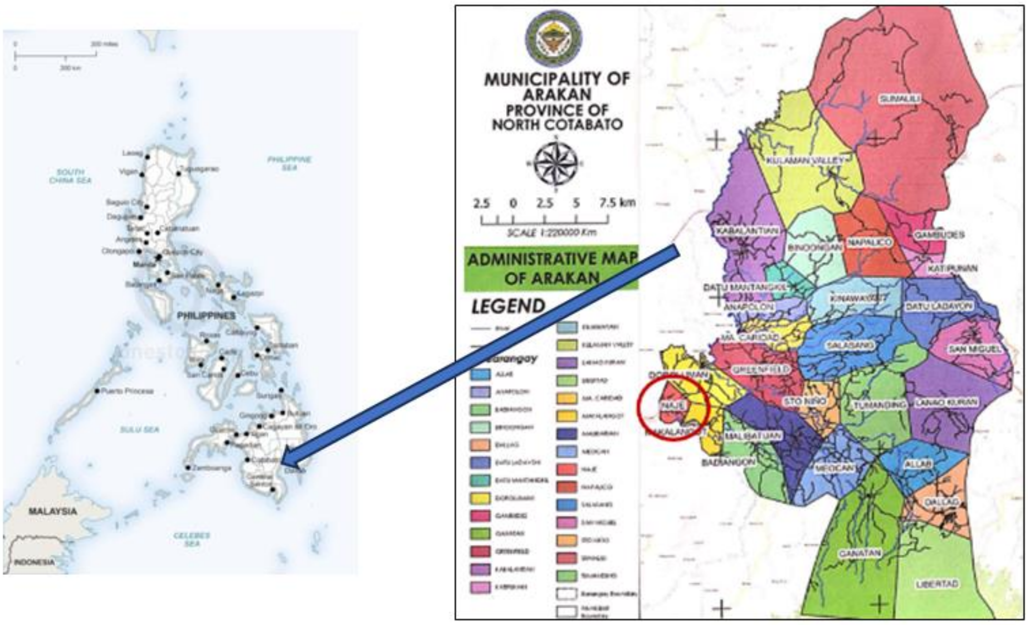

Figure 1: Location of the study (Sources: Municipal Government of Arakan, Cotabato, Philippines; and https://www.onestopmap.com/philippines/philippines-309/)

The materials for planting, incubation, and harvesting oyster mushrooms included an inoculation chamber, hand sprayer, cellophane, calculator, forceps, ruler, iron rod, laptop, marker or ballpen, record book, used printed paper, cut PVC pipe, tape measure, denatured alcohol, cotton, grain spawn, bleach, digital weighing scale, stainless steel pan weighing scale, rope, water container drum, lime, various tree substrates (coconut, rubber, and gmelina sawdust), and other laboratory materials. The researchers collected 45 kilograms of both fine and rough sawdust from coconut, gmelina, and rubber trees. These sawdust materials were cleaned, composted, and cooled before being packed into 6x12x0.02 plastic bags weighing 600 grams each. Pure sources of tree sawdust were used as substrates to ensure consistency in preparation throughout the process.

To maintain contamination-free mushroom tissues during the inoculation and incubation periods, the researchers employed an empty petroleum drum to sterilize the composted fruiting bags for approximately 8-10 hours with a continuous slow fire, a necessary process to eliminate harmful microorganisms. In collaboration with members of the Naje Community Farmers' Association (NACOFA), the researchers planted the mushroom spawn in a sterilized area of the mushroom house. The fruiting bags, colonized with at least 75% mother spawn, took 37-45 days for the first flush to appear. Daily monitoring for signs of contamination was conducted, and the fruiting bags were sprinkled with cool water two to three times a day to maintain moisture. To keep the area cool, potted ferns were strategically placed around the mushroom house. Ferns, also known as pteridophytes, offer significant ethnobotanical benefits such as food and medicine, and possess considerable ecological value. They enhance environmental conditions by absorbing methane gas, improving soil fertility, and mitigating

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heavy metal contamination, such as arsenic. Additionally, ferns can serve as ecological indicators for monitoring microclimate changes. An increase in relative humidity, facilitated by ferns, can effectively reduce the temperature of the surrounding area (Othman et al., 2015; Su & Lin, 2015). Fourteen to twenty-one days post-inoculation, the researchers observed that the fruiting bags were fully colonized with mother spawn or mushroom mycelia. Regular inspections were conducted to identify any signs of contamination, and any contaminated bags were promptly replaced with buffer fruiting bags to ensure the integrity and health of the mushroom cultivation process.

Figure 2: The setup and conditions under which fruit bags are incubated, providing an appropriate environment, temperature, humidity, and duration.

To enhance the growth of the fruiting bodies, the researchers maintained the substrates' moisture by watering them two to three times daily. This was achieved by opening the bags and spraying the substrates. Consequently, the mushroom fruiting bodies began to emerge from the substrate inside the compost bags within three to four days.

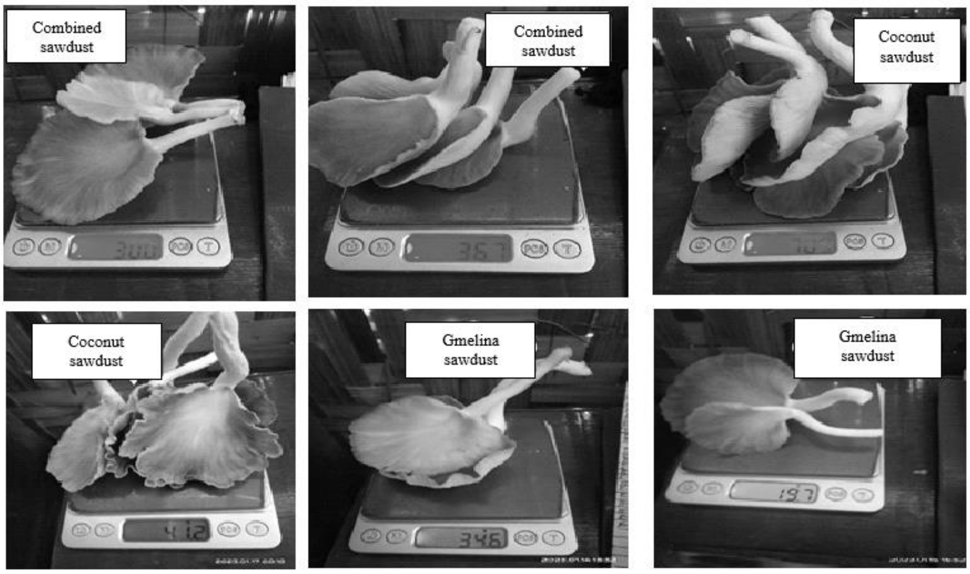

Figure 3: Harvested oyster mushrooms are weighed to calculate the total yield (g).

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Mature mushrooms were harvested by gently grasping the stalk and twisting and pulling the mushroom head. To avoid damaging the base of the young fruiting bodies, which could produce additional fruits, premature mushroom fruits were carefully cut using a blade. Harvesting was conducted daily, preferably in the morning, based on the maturity of the fruits. After each harvest, the bags were sprayed with a minimal amount of water to maintain moisture. The harvested mushrooms remained fresh for up to three to six days when stored in a refrigerator or a cool place. The fruits were then packed into 100-gram portions and sold at an affordable price of 35 Philippine Pesos or 350 Philippine Pesos per kilogram.

The yield of Pleurotus was measured by daily weighing all the fruit harvested from 20 fruiting bags per treatment using a digital scale. These daily measurements were then consolidated weekly to determine the total yield of oyster mushroom fruits over the entire duration of the experiment.

Return on Investment (ROI) is a crucial metric commonly utilized in decision-making and performance analysis (Botchkarev & Andru, 2011; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2020). In this study, the researchers measured ROI by calculating the income generated from the gross sales and subtracting the total expenses. This value was then divided by the total yield and production cost, using the following formula:

$$\text{Return of Investment} = \frac{\text{Net income}}{\text{Production Cost}} \times 100$$

This methodology enabled a comprehensive assessment of the economic viability and profitability of oyster mushroom cultivation using various tree sawdust substrates.

RESULTS AND DISCUSSION

Results

Effect of Sawdust Texture at Different Tree Sawdust Substrates on the Growth and Yield Performance *Pleurotus* sajur-cajo mushroom.

The study examined the influence of sawdust texture (fine and rough) derived from various tree species on the growth and yield of Pleurotus sajor-caju (oyster mushrooms). Results presented in Table 1 highlight the significant effects of sawdust texture on most growth parameters and yield metrics, with notable exceptions in the number of flushes per batch per bag and stalk length. No significant difference was observed in the combined sawdust texture regarding cap circumference and total yield, including the yield from rubber sawdust.

An analysis of variance (ANOVA) revealed that most parameters were highly significant, except for stalk length ($F = 0.00$, $p < 1.95$), which did not show significance at the 1% and 5% levels. These findings suggest that the texture of sawdust, whether fine or rough, from different tree species substrates significantly impacts the growth and yield of oyster mushrooms.

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Table 1: Oyster Mushroom Growth and Yield Performance in Different Tree Substrates (89% substrate, 10% Molasses & 1% Lime), in a Factorial CRD Experiment with 3 Treatments (t) and 4 Replications (r). (Factor A to each Level of Factor B Comparison)

Different Tree Sawdust Sources & Texture	Length of Mycelia (cm)		No. of Days to Flush	No. of Flushes / bag per batch	Length of Stalk (cm)	Circum ference of Cap (cm)	Fruit Weight (g)	Total Yield (g)
	1wk	2wks						
Coconut fine	6.20^{a}	11.93^{a}	35.73^{a}	4.67	6.30	29.30^{a}	114.48^{a}	1944.50^{a}
Coconut Rough	5.58^{b}	8.24^{b}	45.13^{b}	2.90	5.97	24.23^{b}	38.71^{b}	573.13^{b}
Rubber Fine	5.61^{b}	9.35^{b}	39.97^{a}	5.70	6.40	27.8^{a}	102.43^{a}	1720.93^{a}
Rubber Rough	6.23^{a}	11.96^{a}	55.40^{b}	5.23	6.20	28.87^{b}	97.63^{a}	1831.73^{a}
Gmelina Fine	3.46^{b}	7.50^{b}	37.40^{a}	4.23	5.43	25.40^{a}	56.60^{a}	1023.40^{a}
Gmelina Rough	5.67^{a}	8.32^{a}	45.23^{b}	2.73	5.63	21.87^{b}	29.21^{b}	427.23^{b}
Combined Fine	3.28^{b}	7.32^{b}	37.50^{a}	5.00	5.73	26.17^{a}	72.91^{a}	1364.70^{a}
Combined Rough	6.19^{a}	8.61^{a}	45.90^{b}	2.80	6.10	26.70^{a}	65.48^{a}	1065.63^{a}
F-Test	**116.27****	**5.45***	**1078.00****	**28.0****	0.00^{ns}	**17.05****	**31.57****	**41.82****
Pr (>F)	0.00	0.033	0.00	0.00	0.95	0.00	0.00	0.00
CV	5.50%	2.52%	4.28%	16.34%	5.21%	4.28%	17.42%	16.41%

Means with same letter subscripts are not significantly different.
** = Highly significant at 1%, LSD; * = Significant at 5%, LSD; ns = not significant

Length of Mycelia (1 Week after Planting). The data indicated that rough sawdust, particularly from rubber, gmelina, and combined sources, significantly promoted mycelial growth compared to fine sawdust. The most rapid mycelial growth was observed in rough rubber sawdust (6.23 cm), while the slowest was in combined fine sawdust (3.28 cm). This suggests that coconut and rubber sawdust substrates are more conducive to mycelial development, enhancing growth by 89.04% relative to other substrates.

Length of Mycelial Run after 2 Weeks of Planting (cm). Fine-textured coconut sawdust (11.93 cm) exhibited significantly higher mycelial growth than its rough counterpart. In other cases, rough sawdust substrates such as rubber (11.96 cm), gmelina (8.32 cm), and combined (8.61 cm) showed superior mycelial growth. Rough rubber sawdust increased mycelial growth by 27.91% compared to fine rubber sawdust and produced the fastest mycelial run among all tree substrates, demonstrating a 63.39% increase over fine gmelina sawdust.

Number of Days to Flush After Planting. Fine sawdust substrates significantly reduced the number of days to flush compared to rough sawdust. Fine-textured coconut sawdust resulted in the earliest fruiting at 35.73 days, which is 55.05% earlier than rough rubber sawdust. These findings indicate that fine-textured sawdust from various tree species facilitates earlier fruiting of oyster mushrooms.

Number of Flushes per Batch per Bag. Rubber tree sawdust (5.47 flushes) exhibited the highest mean number of flushes per batch per bag. Fine sawdust substrates (4.90 flushes) outperformed rough sawdust (3.42 flushes), with fine rubber sawdust achieving the highest

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number of flushes per bag (5.70). Fine rubber sawdust demonstrated a 57.18% increase in the number of flushes compared to other tree sawdust sources.

Length of Mushroom Stalk/Stipe (cm). The texture of different tree sawdust substrates showed no significant differences in stalk length. However, fine rubber sawdust had the highest mean stalk length (6.40 cm), while fine gmelina sawdust had the lowest (5.43 cm). Overall, stalk length was not significantly influenced by the texture or source of the substrates.

Circumference of Mushroom Cap (cm). Fine-textured coconut (29.30 cm) and gmelina (25.40 cm) sawdust substrates resulted in significantly larger cap circumferences compared to rough sawdust. Conversely, rough rubber sawdust (28.87 cm) yielded larger caps than fine rubber sawdust (27.80 cm). The use of fine coconut sawdust can increase cap girth by 20.92%, and fine gmelina sawdust by 33.97%, compared to their rough counterparts.

Average Weight of Fruits per Bag. Fine-textured coconut (114.48 g) and gmelina (56.60 g) sawdust substrates yielded significantly heavier fruits compared to rough coconut (38.71 g) and gmelina (29.21 g) sawdust. Rubber and combined sawdust treatments showed no significant differences in fruit weight. These findings suggest that fine sawdust can enhance fruit weight by 102% to 292%, with fine coconut sawdust increasing fruit weight by 102% compared to other fine sawdust and by 291.89% compared to rough gmelina sawdust.

Total Yield (g). Fine-textured substrates from coconut (1944.50 g) and gmelina (1023.40 g) produced significantly higher total yields compared to rough sawdust substrates, which yielded 573.13 g and 427.23 g, respectively. No significant differences were observed in total yield for rubber and combined sawdust treatments based on texture. These results highlight the significant impact of substrate texture and type on the total yield of oyster mushrooms. Fine-textured coconut and rubber substrates can maximize yield and profitability, with fine coconut sawdust potentially increasing yield by approximately 90% compared to other fine sawdust and by 355% compared to rough gmelina sawdust.

Effect of Different Tree Substrates (Fine and Rough Sawdust) on the Growth and Yield Performance of *Pleurotus sajur-cajo* Mushroom

The findings in Table 2 indicate that coconut fine sawdust significantly outperformed other substrates across all parameters tested, while fine rubber sawdust excelled in the number of flushes and stalk length. Among the rough sawdust treatments, rubber rough sawdust demonstrated superior performance across all analyzed parameters. The study revealed that both the type of tree sawdust and its texture significantly influenced the growth and yield of P. sajor-caju, with the exception of the number of flushes per bag per batch and stalk length.

Length of Mycelia (1 Week after Planting). Among the fine sawdust substrates, coconut tree sawdust exhibited the highest mycelial growth, averaging 6.20 cm, significantly surpassing rubber (5.61 cm), gmelina (3.46 cm), and the combined sawdust mix (3.28 cm). In the rough sawdust category, rubber and combined sawdust showed similar mycelial growth, with 6.23 cm and 6.19 cm, respectively, both significantly higher than coconut (5.58 cm) and gmelina (5.67 cm).

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Table 2: Oyster Mushroom Growth and Yield Performance in Different Tree Substrates (89% substrate, 10% Molasses & 1% Lime), in a Factorial CRD Experiment with 3 Treatments (t) and 4 Replications (r). (Factor B to each Level of Factor a Comparison)

Different Tree Sawdust Sources & Texture	Length of Mycelia (cm)		No. of Days to Flush	No. of Flushes/bag per batch	Length of Stalk (cm)	Circumference of Cap (cm)	Fruit Weight (g)	Total Yield (g)
	1wk	2wks						
FINE								
Coconut	6.20[a]	11.93[a]	35.73[a]	4.67	6.30	29.30[a]	114.48[a]	1944.50[a]
Rubber	5.61[b]	9.35[b]	45.13[b]	5.70	6.40	27.83[ab]	102.43[a]	1720.93[a]
Gmelina	3.46[c]	7.65[c]	39.97[a]	4.23	5.43	25.40[c]	56.60[b]	1023.40[b]
Combined	3.28[c]	7.32[c]	55.40[b]	5.00	5.73	26.17[bc]	72.91[b]	1364.70[b]
ROUGH								
Coconut	5.58[b]	8.24[b]	45.13[a]	2.90	5.97	24.23[b]	38.71[c]	573.13[c]
Rubber	6.23[a]	11.96[a]	55.40[c]	5.23	6.20	28.33[a]	97.63[a]	1831.73[a]
Gmelina	5.67[b]	8.32[b]	45.23[b]	2.73	5.63	21.87[c]	29.21[c]	427.23[c]
Combined	6.19[a]	8.61[b]	45.90[b]	2.80	6.10	26.70[a]	65.48[b]	1065[b]
F-Test (B)	**37.89****	**221.54****	**112.01****	**10.29****	**6.81****	**16.68****	**21.00****	**26.56****
Pr (>F)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
F-Test (A&B)	44.64**	**209.69****	**31.41****	**1.76[ns]**	**1.68[ns]**	**9.68****	**10.24****	**14.11****
Pr (>F)	0.0000	0.0000	0.0000	0.1947	0.2107	0.0007	0.0005	0.0001
CV	5.50%	2.52%	4.28%	16.34%	5.21%	4.28%	17.42%	16.41%

Means with same letter subscripts are not significantly different.
** = Highly significant at 0.01 or 1%, LSD

Length of Mycelial Run after 2 Weeks Planting (cm). For fine sawdust substrates, coconut sawdust displayed significantly greater mycelial growth, with an average of 11.93 cm, compared to rubber (9.35 cm), gmelina (7.65 cm), and the combined sawdust mix (7.32 cm). In the rough sawdust category, rubber sawdust led the way with 11.96 cm, significantly outperforming coconut (8.24 cm), gmelina (8.32 cm), and the combined sawdust mix (8.61 cm).

Number of Days to Flush After Planting. The results presented in Table 2 show that fine sawdust from coconut and gmelina were more effective in reducing the number of days to flush compared to rubber and combined sawdust. Among the rough sawdust substrates, coconut sawdust resulted in the earliest flush, at 45.13 days. Overall, regardless of texture, coconut sawdust demonstrated the best performance, achieving flushes in just 35.73 days, which is 55.05% earlier than the other treatments.

Number of Flushes per Batch per Bag. The pairwise mean comparison revealed no significant difference among the various tree sawdust substrates. However, rubber sawdust, whether fine or rough, stood out significantly with a mean of 5.47 flushes. The use of rubber substrates notably increased the number of flushes by 57.18% compared to other substrates.

Length of Mushroom Stalk/Stipe (cm). The data presented in Table 2 indicate that the various types of tree sawdust substrates did not significantly affect the growth of Pleurotus sajor-caju

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mushrooms, as evidenced by the lack of significant differences within factor B. However, it is noteworthy that the highest mean stalk lengths were achieved with rubber sawdust, measuring 6.40 cm in fine sawdust and 6.20 cm in rough sawdust.

Circumference of Mushroom Cap (cm). Coconut sawdust with a fine texture produced the widest cap circumference at 27.83 cm, although this was not significantly different from rubber sawdust, which also measured 27.83 cm. In the rough sawdust category, rubber sawdust achieved the highest mean circumference of 28.33 cm, but this was not significantly different from the combined sawdust, which measured 26.70 cm.

Average Weight of Fruits per Bag. Coconut sawdust with a fine texture achieved the highest fruit weight at 114.48 grams, although this was not significantly different from rubber sawdust at 102.43 grams. Among the rough sawdust substrates, rubber sawdust produced the heaviest fruits, weighing 97.63 grams, significantly surpassing the other types of tree sawdust.

Total Yield (g). Fine-textured coconut sawdust produced the highest total yield at 1944.50 grams, though this did not significantly differ from rubber sawdust at 1720.93 grams. Among rough sawdust substrates, rubber sawdust yielded the highest total yield at 1831.73 grams, significantly differing from other types of tree sawdust. These findings suggest that using different tree sawdust substrates can increase yield and potentially enhance income generated from this commodity.

Return of Investment (ROI). Table 3 presents the return on investment (ROI) for oyster mushroom cultivation using different tree sawdust substrates with both fine and rough textures. The analysis is based on an estimated production over six months, utilizing a total of 480 fruiting bags. This study was conducted under the climatic conditions of Barangay Naje, Arakan, Cotabato, where temperatures range from an average high of 84°F (29°C) to a low of 71°F (22°C). The climate in this region is generally warm and humid, yet pleasantly cool (GMAO, 2015).

Table 3: Income Statement of Four Hundred Eighty (480) Fruiting Bags of Oyster Mushroom Producing for six (6) Months Approximately, December 2022-May 2023

Particulars	Coconut Sawdust	Rubber Sawdust	Gmelina Sawdust	Combined Sawdust
Fine Sawdust				
Gross Income	4083.45	3613.95	2149.14	2865.87
Total Expenses	2113.00	2113.00	2113.00	2113.00
Net Income	1970.45	1500.95	36.14	752.87
ROI (%)	**93.25%**	**71.03%**	**1.71%**	**35.63%**
Rough Sawdust				
Gross Income	1203.57	3846.63	897.18	2237.82
Total Expenses	2113.00	2113.00	2113.00	2113.00
Net Income	-909.43	1733.63	-1215.82	124.82
ROI (%)	**-43.04%**	**82.05%**	**-57.54%**	**5.91%**

Assumption: * Production is calculated for 6 months.

* Each fruiting bag (600g) costs P100.00 and sold for 300/kg or 35/100g.

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ROI for Fine Sawdust Substrates. Table 3 details the net income statement for 480 fruiting bags, optimized for a six-month production period. The results demonstrate that fine coconut sawdust yields the highest net income at 1970.45 pesos, with a return on investment (ROI) of 93.25%. This is followed by fine rubber sawdust, which generates a net income of 1500.95 pesos, and fine combined sawdust, producing 752.87 pesos. Fine gmelina sawdust results in the lowest net income, amounting to only 36.14 pesos.

The substantial difference in net income between coconut fine sawdust and gmelina fine sawdust, amounting to 1934.31 pesos, highlights the significant impact of substrate type on the estimated production and net income of oyster mushroom cultivation. Fine coconut and fine rubber sawdust substrates are the most profitable for oyster mushroom cultivation, evidenced by their superior net income and ROI. In contrast, fine gmelina sawdust is the least suitable option due to its minimal net income. These findings underscore the importance of selecting high-quality sawdust substrates for optimizing yield and profitability in oyster mushroom cultivation. The current cultivation technology remains largely traditional, relying heavily on the expertise and experience of mushroom entrepreneurs. This traditional approach is prevalent among farmers and entrepreneurs (Kusrini et al., 2019), emphasizing the need for more systematic and research-based methodologies to enhance the agricultural sector's development.

ROI for Rough Sawdust Substrates. The analysis of the return on investment (ROI) for rough sawdust substrates reveals that rough rubber sawdust achieved the highest net income of 1733.63 pesos, with an ROI of 82.05%. This was followed by rough combined sawdust, which produced a net income of 124.82 pesos. In contrast, rough gmelina sawdust and rough coconut sawdust resulted in negative net incomes, with deficits of 1215.82 pesos and 909.43 pesos, respectively.

These findings suggest that the type of sawdust substrate significantly impacts the profitability of oyster mushroom cultivation. Among the four types of sawdust evaluated, rough rubber sawdust emerged as the most advantageous substrate. Conversely, the use of rough gmelina or rough coconut sawdust led to negative net incomes, indicating that these substrates are not viable options for oyster mushroom cultivation under the existing climatic conditions.

The potential for mushroom cultivation to serve as a lucrative income source is underscored by the ability of mushrooms to grow on agricultural waste materials such as sawdust, sugarcane sludge, and coconut husk ash. In countries where exports are a primary source of income, mushroom farming could become a significant agricultural crop. Research by Olujobi and Adeniji (2021) and Cyriacus et al. (2021) found that mushrooms produced more and were more productive when grown on rice straw compared to substrates made of rubber, mahogany, and crushed baobab fruit shells.

Additionally, Miah et al. (2017) reported that sawdust substrates yielded the highest average number of fruiting bodies, the highest average weight of fruiting bodies, the highest biological and economic yields, and the highest benefit-cost ratio (BCR). These studies collectively highlight the importance of substrate selection in optimizing the growth, yield, and profitability of oyster mushroom cultivation.

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DISCUSSION

The overall findings of this study corroborate those of Chang and Miles (2004), Jambaro et al. (2014), Nsoh et al. (2022), Oei (2004), and Royse (2014), emphasizing that sawdust substrates, regardless of texture, are pivotal in influencing the yield and quality of Pleurotus sajor-caju. This is attributed to sawdust's high water-holding capacity, nutrient content, and availability. The selection of tree sawdust substrate and its texture significantly impacts mycelial growth (Bhattacharjya et al., 2024; Miah et al., 2017), with coconut sawdust being a prevalent substrate in commercial production (Decena and Del Rosario, 2022; Sopit, 2007).

In addition, Muswati et al. (2021) demonstrated that utilizing sawdust as agricultural waste resulted in the fastest mycelial colonization rate, the shortest time to the first harvest, and the highest number of pins and stipe girth, underscoring the substantial influence of substrate composition on oyster mushroom growth and yield. Additionally, studies by Adebayo and Martinez-Carrera (2015), Chukwurah et al. (2013), and Bellettini et al. (2019) have shown that mushroom cap size is affected by factors such as temperature, relative humidity, ventilation, and substrate moisture content, and that Pleurotus species are effective lignin degraders.

Further research by Boadu et al. (2023) and Muslimin et al. (2021) confirmed that oyster mushrooms grow rapidly on sawdust substrates, with substrate type and environmental conditions significantly impacting mycelial growth development (Neizer et al., 2020). However, rough sawdust substrates are recommended due to their availability and suitability as spawning habitats, leading to increased yields, mycelium run, and overall growth (Mondal et al., 2010; Hoa, 2015).

Moreover, oyster mushrooms grown on sawdust substrates have exhibited the highest yields (Biswas et al., 2016; Rambey et al., 2018), with maximum yields obtained from these substrates (Varghese & Amritkumar, 2020). Higher spawn rates can lead to faster colonization and shorter times to fruiting, ultimately resulting in higher yields. Moreover, temperature and humidity are critical factors influencing the growth and yield of P. sajor-caju (Shah, 2021; Sanchez, 2010).

Very important for oyster production is that the optimal temperature for cultivation should range from 20 to 28°C, with relative humidity maintained between 80% and 90% (Cikarge & Arifin, 2018; Sanchez, 2010). With that, mushroom growers can benefit from monitoring the growth stages of the mushrooms and optimizing environmental conditions to achieve maximum yield (Muswati et al., 2021).

CONCLUSIONS

The findings indicate that the type and texture of sawdust substrates could significantly influence the growth parameters and yield of oyster mushrooms. In fact, fine-textured coconut sawdust emerged as the most effective substrate, demonstrating superior performance in terms of mycelial length (cm), days to flush, cap circumference (cm), fruit weight (g), and total yield (kg). This substrate yielded the highest net income and return on investment (ROI), making it the most profitable option for oyster mushroom cultivation.

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Moreover, fine rubber sawdust also showed high profitability, particularly excelling in the number of flushes and stalk length. In contrast, rough sawdust substrates, specifically from gmelina and coconut, resulted in negative net incomes, indicating their unsuitability under the given climatic conditions. Finally, the significant interaction between the type of tree sawdust and its texture underscores the importance of selecting appropriate substrates to maximize yield and profitability. The study's findings provide valuable insights for mushroom producers, emphasizing the need for optimized substrate selection to enhance agricultural productivity and economic returns. These results support the potential for mushroom cultivation to serve as a lucrative source of income, particularly in regions with similar climatic conditions to Barangay Naje.

However, it is important to note that this study faced several limitations, including geographical constraints, as it was conducted exclusively in Barangay Naje, Arakan, Cotabato, Philippines, limiting the generalizability of the findings to other regions with different climatic conditions. Additionally, the research focused on a limited number of tree sawdust substrates (coconut, rubber, and gmelina), potentially overlooking other substrates that could influence mushroom growth and yield. The six-month production period provided short-term insights but did not account for long-term impacts and sustainability over multiple cultivation cycles. Furthermore, the economic analysis was based on specific market prices and costs prevalent in the study area, which may not be applicable in other regions or times.

Environmental control variations and limited replications were also noted, with specific temperature and humidity conditions typical of the study area, which may affect reproducibility elsewhere. The exclusion of biotic factors such as pests and diseases, and the laboratory-like conditions of the sterilization and cultivation processes, could affect the practical implementation and scalability of the study's recommendations. These limitations suggest a need for future research to explore a broader range of substrates, environmental conditions, and long-term sustainability to develop more comprehensive guidelines for oyster mushroom cultivation.

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Conflict of Interest

"The authors declare no conflict of interest."

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