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AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 8
September 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2025; 25(8): 27509-27524 https://doi.org/10.18697/ajfand.145.25345

Date	Submitted	Accepted	Published
	18th September 2024	18th August 2025	3rd October 2025

ENHANCING OYSTER MUSHROOM *(PLEUROTUS OSTREATUS)* YIELD THROUGH THREE SUBSTRATE VARIATIONS: A COMPARATIVE STUDY

Escober JMG[1*]

Joe-an Mae G. Escober

*Corresponding author email: joeanmaeescober@cpsu.edu.ph

College of Agriculture and Forestry, Central Philippines State University, Kabankalan City, Philippines

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ABSTRACT

This study explores the optimization of oyster mushroom (*Pleurotus ostreatus*) cultivation through the experimental variation of substrates, aiming to enhance yield. A comparative analysis of three (3) substrates was analyzed for their efficacy in supporting mushroom growth. The study used a descriptive approach, systematically documenting and analyzing the effects of different substrate compositions on mushroom yield, height, and stem thickness. This experimental approach was used to conduct a comparative analysis of various substrate compositions for mushroom cultivation. The experiment was conducted at Central Philippines State University – Murcia Campus, Negros Island Region, Philippines, from October 2023 to January 2024. While the data shows that Substrate B *(63 % of rice straw (chopped), 10 % of Vermicast, 27 % of sawdust (decomposed)* is more efficient than Substrate A *(Saw dust 79 %, Lime 1 %, Molasses 5 %, Rice bran 15 %)*, leading to better outcomes in both mushroom height and stem thickness, Substrate C *(Rice straw -50 %, Saw dust-30 %, Forest top soil-20 %)* produced the highest yield in its efficiency likely influenced by the specific composition and balance of the substrate. The improved performance of Substrate C may not solely be due to the presence of one factor but also to other factors, such as nutrient availability, moisture retention, and microbial activity, which are affected by the precise combination of ingredients. Differences in components like vermicast, sawdust, or rice bran can significantly impact how the substrate performs overall. Thus, while Substrate C demonstrated superior efficiency in this instance, variations in the composition and proportions of these additional ingredients could play a crucial role in determining yield outcomes. This study suggests that optimizing substrate performance is complex and requires a careful balance of multiple factors to achieve consistent results. Lastly, mushroom farming requires extra time, patience, and proper care to ensure successful growth. Farmers must be diligent in maintaining these factors throughout the growth cycle, as mushrooms are delicate and require constant attention for a healthy, productive harvest. While having the perfect substrate is essential for mushroom cultivation, it does not guarantee a bigger or more abundant yield.

Key words: *Pleurotus ostreatus*, yield enhancement, substrate variations, comparative study, substrate variation

Citation: **Escober JMG** Enhancing Oyster Mushroom (*Pleurotus ostreatus*) Yield Through Three Substrate Variations: A Comparative Study. *Afr. J. Food Agric. Nutr. Dev.* 2025; **25(8):** 27509-27524. https://doi.org/10.18697/ajfand.145.25625

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ISSN 1684 5374

INTRODUCTION

In the Province of Negros Occidental, horticulture has become more popular and marketable. The education sector, in collaboration with other government and private agencies with the support of the Local Government in the province, is trying to promote mushroom cultivation in community backyards as potential source of income. This is because mushrooms are widely used in cooking due to their unique flavors, textures, and nutritional benefits [1]. They are versatile ingredients that can be incorporated into a wide range of dishes. They are low in calories, fat-free, cholesterol-free, and rich in essential nutrients such as protein, vitamins, and minerals, which health-conscious consumers often seek as an addition to their diet. While some crops are seasonal, mushroom cultivation can be carried out year-round, providing a consistent supply of fresh mushrooms regardless of the season. Like any agricultural project, growing Oyster Mushrooms (*Pleurotus Ostreatus*) may be exciting and fulfilling. But it also presents a unique set of issues and difficulties. The first is contamination, such as molds, bacteria, or rival fungi that may contaminate it [2]. Second, the substrate's quality directly impacts the yield of mushrooms. Some experts say that it should be adequately sterilized or pasteurized to eradicate competing organisms and provide an environment rich in nutrients for its development. Moreover, oyster mushrooms need specific environmental parameters, such as humidity, light, and temperature, to flourish, producing a high-quality mushroom for market demand.

Some mushroom growers, especially the new growers, have problems harvesting it [3]. According to them, one problem is substrate variability because it is heavily dependent on substrate composition. Substrates can vary widely regarding nutrient content, moisture retention [4], pH levels, and physical structure, making it difficult to determine the most suitable combination for optimal yield. Secondly, the inefficient use of substrates can lead to wasted resources and increased production costs for mushroom growers [5]. Farmers may struggle to optimize resource allocation and maximize profitability without a clear understanding of how different substrate variations affect yield. Knowing substrate variations in yielding Oyster mushrooms ensures the best quality and flavor [6]. Lastly, harvesting mushrooms at the right time ensures they are fresh and appealing to consumers, enhancing their marketability and potential for higher prices [7].

Thus, this study investigated methods to optimize oyster mushroom yield by examining three (3) substrate variations. Oyster mushroom cultivation heavily depends on substrate composition, and understanding how different substrates influence production efficiency. Through a comparative analysis, this research explored the effects of substrate variations such as composition, nutrient content, and physical characteristics on mushroom yield. By combining traditional

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experimentation with advanced analytical techniques, this study aimed to enhance oyster mushroom cultivation methods and contribute to sustainable food production.

These investigations advance the research by comparative analysis, which makes it possible to identify ideal growth conditions and evaluate intricate data patterns. This comparative analysis facilitates ongoing cultivation practice improvement in addition to quickening the optimization process. Therefore, to improve yields while reducing waste and inefficiencies, farmers may benefit from learning-driven analysis, which will eventually result in more lucrative and sustainable mushroom production.

As a result, higher mushroom yields translate into increased revenue for mushroom farmers. It can also contribute to sustainable food production practices, potentially reducing reliance on less sustainable agricultural practices. Lastly, the findings of this study can expand the scientific understanding of mushroom cultivation and substrate interactions. This knowledge can inform future research endeavors and contribute to agricultural science and technology advancements.

LITERATURE REVIEW

Mushrooms cultivation helps to address the issues of quality food, health, and environmental sustainability. There is a need to promote both mushroom production and consumption to meet the changing needs of food items [8]. The study of Wani *et. al.* [9] on several fungal, bacterial, and viral infections have been found to reduce mushroom yield and quality by competing for nutrients and space or releasing toxic compounds. The disease enters the farm primarily due to a poor hygience practices and the use of unsterilized cultivation materials. According to Nongthombam *et. al*. [10], oyster mushroom production has decreased due to limited knowledge of proper cultivation and harvesting practices. It production entirely depends on the environmental conditions, and the cultivation room needs to be properly sterilized to avoid contamination.

The study by Thakur [11] presents some challenges in mushroom cultivation, such as a lack of technical capacity in production techniques with poorly equipped government-supported advisory services, resulting in interested farmers seeking technology on their own and lacking technical skills to produce high-quality mushrooms. The probable reasons or weaknesses in developing a flourishing mushroom industry are insufficient funds and poor harvest management because mushrooms are perishable and have a concise shelf life with a high moisture content of more than 90%. Preserving mushrooms in fresh condition for a more extended period is difficult and costly. Thus, knowing when to harvest and when not is vital to the new growers. Other challenges in the production of mushrooms, as in the study by Ndem [12] included lack of training, quality of spawns and substrates,

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temperature control, and mushroom diseases that may lead to poor quality of mushroom production.

Although growing mushrooms calls for specific skills and expertise, one of the most frequent problems growers have is a lack of training. Many farmers do not comprehend the precise ambient conditions, sterilizing techniques, and handling procedures required for adequate harvests since they have not received enough instruction in mushroom farming [13, 14]. This lack of expertise often results in poor management of the growing environment, which may cause contamination, decreased output, or even crop loss. Farmers who are not correctly guided may also be ignorant of the varying substrate types and cultivation techniques needed to cultivate different kinds of mushrooms, which would further impede their success [15].

Furthermore, spawn and substrate quality are essential factors in the generation of mushrooms. The entire output might be decreased by poor or contaminated growth caused by low-quality spawns, which are the seeds or fungal elements utilized to proliferate mushrooms. Similar to this, to offer the proper nutrients and environment for mushroom growth, substrate organic materials must be appropriately selected and handled. Poor-quality substrates might be deficient in vital nutrients or contain impurities which can further limit the ability of mushrooms to thrive [16]. Even experienced growers have a difficult time producing a lucrative crop if they do not have access to high-quality spawns and well-prepared substrates [17].

MATERIALS AND METHODS

This experiment was conducted at Central Philippines State University – Murcia Campus, Negros Island Region, Philippines, from October 2023 to January 2024. The University offers agricultural courses throughout its extension campuses [18].

This study integrated both descriptive and experimental approaches to conduct a comparative analysis of various substrate compositions for mushroom cultivation. Initially, a descriptive approach was used to document and outline the characteristics and formulations of different substrates, such as varying ratios of rice straw, vermicast, and sawdust. This step involved systematically recording baseline data on each substrate's composition and its observed effects on mushroom growth parameters. Subsequently, an experimental approach was employed to test these substrates rigorously under controlled conditions. This involved conducting experiments where mushrooms are grown using different substrates, with precise measurements taken for height, stem thickness, and yield. The experimental data was then analyzed to compare the effectiveness of each substrate formulation. By combining these methodologies, the study not only provides detailed descriptions of substrate characteristics but also empirically evaluates their performance, offering a

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September 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

comprehensive understanding of how various substrate components influence mushroom cultivation outcomes.

Preparation

The preparation of substrates involves several crucial steps to ensure optimal conditions for mushroom growth.

Three substrate variations were prepared using organic materials such as agricultural by-products, sawdust, and other nutrient-rich components. These substrates were sterilized and inoculated with *Pleurotus ostreatus* spawn, after which the mushrooms were cultivated under controlled environmental conditions. The substrates were compared based on their ability to enhance yield to identify optimal mixtures for oyster mushroom production. The data collected during this phase served as the foundation for subsequent analysis, providing critical insights into how substrate variation impacts mushroom productivity.

1. Substrate A (Old Substrate)

Substrates

- Saw dust 79 %
- Lime 1 %
- Molasses 5 %
- Rice bran 15 %

Total fruiting bag sample: 30

Weight of fruiting bag: 1 kilo. The table 1 shows the record of the 30 sample fruiting bags with their distinctive size, weight, and height. The 30 fruiting bags underwent 3 weeks of incubation period, and 28 of them were opened after 7-10 days, and their sprout started to develop. The sprout can be harvested after 3-4 days. Unlike the first sample, the Rice straw takes a little longer to sprout after being entirely white. The second sprouts are longer, and it takes 7- 10 days before they bear fruit again.

2. Substrate B (Newly acquired)

Substrates

- 63 % of rice straw (chopped)
- 10 % of Vermicast
- 27 % of sawdust (decomposed)

Total number of fruiting bags: 30

Table 2 shows the record of the 30 sample fruiting bags with their distinctive size, weight, and height. The 30 fruiting bags underwent 4 weeks of incubation period, and 25 of them were opened after 7-10 days, and their sprout started to develop.

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The sprout can be harvested after 3-4 days. The second sprouts take 4-5 days before they bear fruit again.

3. Substrate C

Substrates

- Rice straw -50 %
- Saw dust-30 %
- Forest topsoil-20 %

Total number of fruiting bags: 30

Table 3 shows the record of 30 sample fruiting bags. The fruiting bags took 3 weeks in the incubation room before they were fully white, 25 of them were opened after 3 weeks, and some were after a week. It shows that the size, height, and weight, compared to the two samples, were a little bulky due to the substrates being used, wherein it was hard to compress, yet the cost of production is much lower than the 2. As observed, after 7-10 days, it opened, it began to sprout, and within 4 days, the sprouts could be harvested, but the next sprouts took longer compared to the two substrates.

RESULTS AND DISCUSSION

Comparative Analysis

The performance of each substrate mixture was rigorously evaluated based on the data collected during the cultivation phase. Key metrics, such as mushroom yield, growth rate, and substrate efficiency, were compared across all substrate types.

In the comparative analysis, three (3) substrate mixtures were tested: Substrate A – Old Substrate, Substrate B – Newly acquired, and Substrate C. The yield, growth rate, and number of stems on the first harvest were measured. The comparative analysis was the result from Table 1 (Record of the sample fruiting bags on the first harvest using substrate A, Table 2 (Record of the sample fruiting bags on the first harvest using substrate B), and Table 3 Record of the sample fruiting bags on the first harvest using substrate C.

The analysis revealed that substrate C produced the highest yield most efficiently. Substrates A and B also performed well, though Substrates proved to be less effective in yield and harvest. These findings suggest that substrates with higher nutrient content, like 50% of rice straw, 30% sawdust and 20% of forest topsoil.

Comparative Analysis (per factors present in each substrate)

The data in Table 5 demonstrates that Substrate C is more efficient than Substrate A and B regarding mushroom height and stem diameter. Mushrooms grown in Substrate C achieved an average height of 7.68cm, compared to A with 6. 87 cm

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Volume 25 No. 8
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PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

and B with 6.93 cm. In terms of no. of the stem of harvest, indicating a 10% greater vertical growth in Substrate C. Therefore, Substrate C appears to offer superior efficiency in promoting both vertical growth and stem development compared to Substrate A and B. This considerable difference in stem diameter highlights Substrate C's superior ability to support thicker, stronger mushroom stems, which are crucial indicators of healthier and more robust mushroom growth.

Actual Output of the Study

The following images showcase the actual results and experimentation process in the study, highlighting the various stages of mushroom cultivation. Through these pictures, the progression from substrate preparation to mushroom harvest is documented, offering a clear representation of the experimental procedures and their corresponding results.

Figure 1 shows a demonstrator presenting three types of substrates with black soil (left), sawdust mixture (middle), and rice straw (right) to the students of CPSU-Murcia Annex Campus during the substrate preparation stage of the oyster mushroom cultivation experiment.

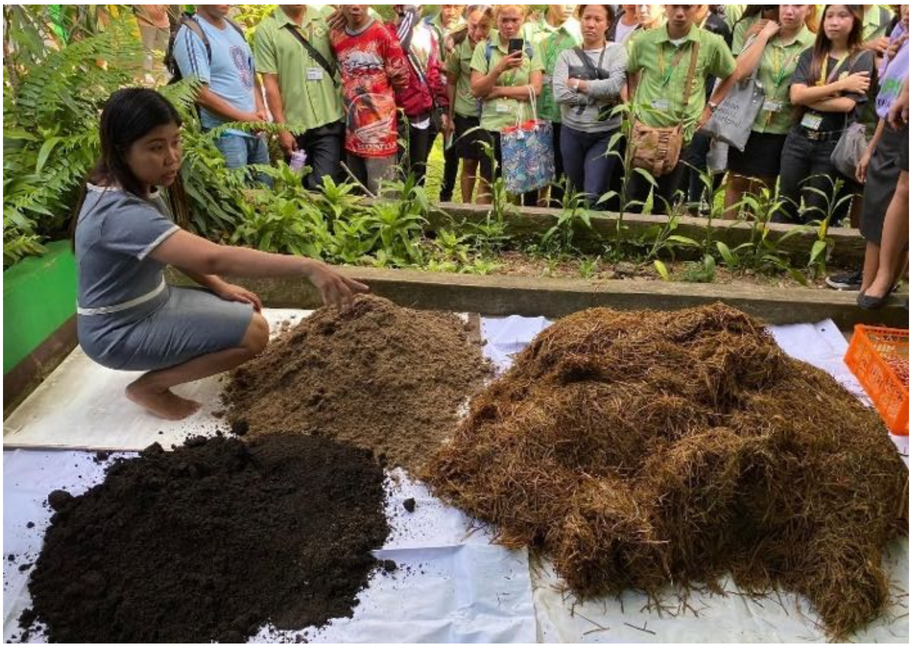

Figure 1: Preparation of substrates during the experimentation phase

Figure 2 shows the successful growth of oyster mushrooms (*Pleurotus ostreatus*) cultivated in sterilized grow bags using various substrate formulations. The mushrooms exhibit healthy fruiting bodies with well-formed caps and stems, indicating effective substrate preparation and favorable growing conditions.

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SCHOLARLY, PEER REVIEWED
Volume 25 No. 8
September 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Figure 2: Result of the experimentation (Mushroom)

Figure 3 illustrates the healthy development of oyster mushrooms cultivated using Substrate C, which demonstrated the highest yield and overall efficiency during the experimentation. This result reinforces Substrate C as the most favorable among the three tested, highlighting its commercial potential for mushroom farming.

Figure 3: Substrate C actual result

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CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

Mushroom production requires a lot of effort, and it takes time to learn the process. But the fruit of harvest is sweet, and the three samples show how trash turns into money. The Central Philippines State University – Murcia Campus is trying to formulate and develop technology so that farmers can easily adopt the technology and use it as a source of earnings. The first sample is growing a mushroom in sawdust, molasses, lime, and rice bran. One bottle of spawn can be planted in the range of 20- 30 fruiting bags, the same with the 2 remaining samples. However, the difference between them is the cost of production, wherein the first sample is costly compared to the 2 samples. In some ways, they only differ in the incubation period: the first sample takes 1 month, and the second is only 3 weeks. With the same process and the same materials, the outcome was mostly the same. The improved performance of Substrate C may not solely be due to the presence of one factor but also to other factors such as nutrient availability, moisture retention, and microbial activity, which are affected by the precise combination of ingredients.

Based on the findings, it is recommended that growers adopt a substrate formulation rich in nutrients to optimize oyster mushroom yields. Specifically, incorporating a substrate mix of 50% rice straw, 30% sawdust, and 20% forest topsoil has demonstrated superior performance in enhancing mushroom growth and yield. This nutrient-rich combination leverages the high nutrient content and the structural benefits of rice straw and decomposed sawdust, creating an ideal environment for robust mushroom development. Although substrate A also showed promising results, its effectiveness was limited compared to substrate B.

ACKNOWLEDGEMENTS

This is to acknowledge the support of Central Philippines State University in the publication of this paper and the students of the agriculture program for their full support in conducting the study.

Conflict of interest

The authors whose names are listed certify that they have NO affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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Volume 25 No. 8
September 2025
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ISSN 1684 5374

Table 1: Record of the sample fruiting bags on the first harvest using substrate A

List of samples	Weight (kg)	Height (inches)	Size (cm)	No. Of stem on the first harvest
	1	7 inches	31 cm	9
	1	6 inches	31 cm	12
	1	7 inches	31 cm	6
	1	6.5 inches	31 cm	7
	1	7 inches	31 cm	5
	1	6 inches	31 cm	7
	1	7.5 inches	31 cm	9
	1	6 inches	31 cm	6
	1	6.5 inches	31 cm	9
.	1	7 inches	31 cm	12
.	1	6 inches	31 cm	5
.	1	7 inches	31 cm	7
.	1	6.5 inches	31 cm	8
.	1	7.5 inches	31 cm	3
.	1	8 inches	31 cm	7
.	1	7.5 inches	31 cm	4
.	1	8 inches	31 cm	7
.	1	7 inches	31 cm	8
.	1	7 inches	31 cm	5
.	1	6 inches	31 cm	5
.	1	7.5 inches	31 cm	3
.	1	7.5 inches	31 cm	9
.	1	7.5 inches	31 cm	4
.	1	7 inches	31 cm	7
.	1	6.5 inches	31 cm	8
.	1	6 inches	31 cm	5
.	1	7 inches	31 cm	6
.	1	6 inches	31 cm	8
.	1	7 inches	31 cm	7
.	1	7 inches	31 cm	4
		Average: 6. 87		Harvest per week: 1 -1.5

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Volume 25 No. 8
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PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 2: Record of the sample fruiting bags on the first harvest using substrate B

List of samples	Weight (kg)	Height	Size (cm)	No. Of stem on the first harvest
	1	6 inches	31 cm	10
	1	6 inches	31 cm	12
	1	6.5 inches	31 cm	8
	1	7 inches	31 cm	8
	1	6 inches	31 cm	5
	1	6 inches	31 cm	7
	1	7 inches	31 cm	4
	1	8 inches	31 cm	9
	1	8 inches	31 cm	5
.	1	7.5 inches	31 cm	11
.	1	7 inches	31 cm	10
.	1	7.5 inches	31 cm	9
.	1	8 inches	31 cm	12
.	1	6 inches	31 cm	7
.	1	6 inches	31 cm	9
.	1	7 inches	31 cm	6
.	1	6.5 inches	31 cm	8
.	1	7 inches	31 cm	10
.	1	7.5 inches	31 cm	7
.	1	7 inches	31 cm	10
.	1	8 inches	31 cm	4
.	1	8 inches	31 cm	12
.	1	7 inches	31 cm	5
.	1	7 inches	31 cm	3
.	1	6 inches	31 cm	11
.	1	6.5 inches	31 cm	8
.	1	7 inches	31 cm	6
.	1	7 inches	31 cm	4
.	1	6.5 inches	31 cm	10
.	1	7.5 inches	31 cm	7
		Average: 6.93		Harvest per week: 1 – 1.5

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ISSN 1684 5374

Table 3: Record of the sample fruiting bags on the first harvest using substrate C

List of samples	Weight (kg)	Height	Size (cm)	No. Of stem on the first harvest
	1	8 inches	31 cm	7
	1	7.5 inches	31 cm	11
	1	7.5 inches	31 cm	10
	1	8 inches	31 cm	7
	1	8 inches	31 cm	5
	1	7.5 inches	31 cm	8
	1	7 inches	31 cm	7
	1	8 inches	31 cm	9
	1	8 inches	31 cm	6
.	1	8 inches	31 cm	11
.	1	7.5 inches	31 cm	10
.	1	7.5 inches	31 cm	6
.	1	8 inches	31 cm	9
.	1	8 inches	31 cm	8
.	1	7 inches	31 cm	7
.	1	8 inches	31 cm	9
.	1	8 inches	31 cm	10
.	1	7.5 inches	31 cm	6
.	1	8 inches	31 cm	12
.	1	8 inches	31 cm	8
.	1	8 inches	31 cm	7
.	1	7.5 inches	31 cm	9
.	1	7.5 inches	31 cm	11
.	1	8 inches	31 cm	9
.	1	8 inches	31 cm	7
.	1	8 inches	31 cm	10
.	1	7 inches	31 cm	12
.	1	7 inches	31 cm	8
.	1	7.5 inches	31 cm	11
.	1	7 inches	31 cm	7
		Average: 7.68		Harvest per week: 1

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Table 4: Comparative Analysis Result

Substrate	Height (average)	No. of stem on per week harvest (average)
Substrate A	6. 87	6.73
Substrate B	6.93	7.9
Substrate C	7.68	8.57

Table 5: Descriptive Analysis of the three substrates

	ht			Stem		
	A	**B**	**C**	**A**	**B**	**C**
Valid	30	30	30	30	30	30
Missing	0	0	0	0	0	0
Mean	6.867	6.933	7.68	6.733	7.900	8.57
Std. Deviation	0.615	0.691	0.382	2.273	2.631	1.924
Minimum	6.000	6.000	7.000	3.000	3.000	5.000
Maximum	8.000	8.000	8.000	12.000	12.000	12.000

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