Techno Agriculturae Studium of Research, 1(4) - December 2024 233-244

Effects of Different Level of Sawdust Substrates on the Growth and Yield of Oyster Mushroom (Pleurotusostreatus)

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Received: Nov 19, 2024	Revised: Nov 22, 2024	Accepted: Dec 25, 2024	Online: Dec 24, 2024

ABSTRACT
The objective of the experiment was to test the effect of different levels of sawdust substrates on the growths and yields of oyster mushroom. The experimental design was a Randomized Complete Block Design (RCBD) involved five treatments and four replications. The treatments were T1: rice husk 70% plus other substrate, T2: rice husk 80% plus other substrate, T3: rice husk 90% plus other substrate, T4: rice husk 80% plus other substrate and T5: rice husk 100% plus with other substrate. A total of 500 bags were representatives for 5 treatments or 100 bags for 4 replications or 25 bags for one replication. Three randomize mushroom bags among 25 bags in each replications were representative samples to measurement. Though the experiment shows that length, cap diameter, number of fruit body/packet, yield/packet and total yield in 25 bags were not significant different (P>0.05) among different treatments but total yield was better when sawdust used at 80%and substrates from rice husk (25%), rice straw (5%), rice bran (5%) and other element substrates.

Keywords: *Mushroom Production, Oyster Mushroom, Sawdust Substrates*

Journal Homepage https://journal.ypidathu.or.id/index.php/agriculturae

How to cite: Or, C., Sin, P., Hong, C., Ros, V., Kang, T., Pen, D. & Serey, M. (2024). Effects of Different Level of Sawdust Substrates on the Growth and Yield of Oyster Mushroom (Pleurotusostreatus). *Techno Agriculturae Studium of Research*, 1(4), 233-244. https://doi.org/10.70177/agriculturae.v1i4.1513
Published by: Yayasan Pendidikan Islam Daarut Thufulah

INTRODUCTION

Oyster mushroom cultivation plays an important role in managing organic wastes whose disposal has become a problem (Mukherjee 2007). These wastes can be recycled into food and environment may be less endangered by pollution (Eswaran et al 2000).

Strengthening mushroom production sector could be essential in order to increasing and diversifying business and employment opportunities in the rural areas, and providing income opportunities of small family farms.

Mushrooms are a good source of non starchy carbohydrates, with high content of dietary fiber and moderate quantity of proteins, including most amino acids, minerals, and vitamins (Croan, 2004). The protein content varies from 1.6 to 2.5%, and the niacin content is about ten times higher than that of any other vegetable. Moreover, Randive (2012) reported that oyster mushrooms are rich in Vitamin C, B complex, and mineral salts required by the human body. Oyster mushroom can grow at moderate temperatures, ranging from 20 to 30°C, and at a humidity of 55–70%, on various agricultural waste materials used as substrate. Because of its flexible nature, the Pleurotusgenus is more cultivated than any other mushroom species (Rosado et al 2002). The climatic conditions are ideal for the cultivation of the oyster mushroom (Amin et al 2007b). To successful cultivation, it is important to select high yielding strains, appropriate substrate and available for farmers. However, the production and yield performance of commercial strains of mushrooms tends to decrease after consecutive sub culturing (Naraian et al 2011). Beside strain, different substrate and its quality are also factors that can be effect of mushroom production. Therefore, more information about different substrates is necessary to identify good substrate and good production (Uhart et al., 2008).

The objective of the experiment was to test the effect of different level of sawdust substrates on the growth and yield of oyster mushroom (Pleurotusostreatus).

RESEARCH METHODOLOGY

Location and duration

The experiment was conducted in February to May 2015 in mushroom culture room in Svay Rieng University located in National Road No 1, Chambak Village, Sangkat Chek, Svay Rieng City, Svay Rieng province.

Experimental design

The experimental design was a Randomized Complete Block Design (RCBD) involved five treatments and four replications. The treatments were:

Table 1: Substrate use in different treatment

Substrate	T1	T2	T3	T4	T5
Rice husk, %	25	25	16	25	0
Sawdust, %	70	80	90	80	100
Rice straw, %	5	5	0	5	0
Rice bran, %	3	5	3	5	10
Urea, %	0	0.5	0	0	0
CaCO3, %	0	1	1	1	1
Palm Sugar, %	1	0	0	0	0
Compost liquid, Liter	18	18	0	90	0
EM, ml	0	250	125	250	0

Sticky rice mill	0	0	1	0	0
Maize mill, %	0	0	0	0	5

A total of 500 bags were representative for 5 treatments or 100 bags for 4 replications or 25 bags for one replication were used in this study. The space in each replication is 0.5m and area for each replication was 1m x 1m (for 25 mushroom bags).

Table 2: Experiment plot layout

Treatment	**T4**	**T1**	**T3**	**T2**	**T5**
	1	1	1	1	1
Replicate	(25 bags)	(25 bags)	(25 bags)	(25 bags)	(25 bags)
Treatment	T2	T3	T1	T5	T4
	2	2	2	2	2
Replicate	(25 bags)	25 bags	25 bags	25 bags	25 bags
Treatment	T1	T2	T4	T5	T3
	3	3	3	3	3
Replicate	(25 bags)	(25 bags)	(25 bags)	(25 bags)	(25 bags)
Treatment	T2	T5	T1	T4	T3
	4	4	4	4	4
Replicate	(25 bags)	(25 bags)	(25 bags)	(25 bags)	(25 ags)

Procedure

a) Subtract use

The substrates were different based on treatment and those substrates are available products and easy to find in everywhere. The substrate consisted of rice husk, sawdust, rice straw, rice bran, Urea, CaCO3,palm sugar, compost liquid, EM, sticky rice mill and maize mill. The substrate were put a polypropylene bag sealed with cotton wool with capacity of 500g.

b) Development of strain

The strains were produced by the researcher team of Svay Rieng University and used in this study.

Photo 1: Equipment use for making strains (Source: Project Team)



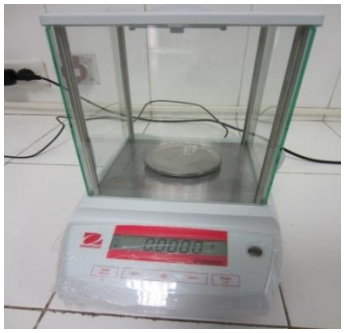

Photo 2: Material use for making strain (Source: Project Team)

c) Preparing the mushroom bags in culture room

After completing the processing of strains, the substrates and strains were mixed together based on treatment. The packets of each mushroom were placed separately based on treatment, side-by-side, and hang in the culture room.

Photo 3: Mushroom in culture room (Source: Project Team)

d) Moisture and water supply

The moisture of the culture room was maintained at 80–85% relative humidity by spraying water three times per day or more expend on the weather conditions in the culture room. The room lighting was maintained. The temperature of the culture house was maintained between 22 and 25°C. Water was sprayed regularly to maintain humidity (80–85%). Three flushes of each packet were harvested and recorded.

e) Harvested

Oyster mushrooms achieved maturity within two to three days after primordial initiation. The matured fruiting body was identified by the curve margin of the cap, as described by Amin et al. (2007b). Mushrooms were harvested by twisting to uproot from the base. After harvesting of the first flush, packets were scraped again in the position. The packets were soaked in a bucket for 15 min, inverted for another 15 min to remove excess water, and placed in the culture house. This practice was repeated after each flush.

Measurements

The length, cap diameter, number of fruit body/packet, yield/packet and total yield in 25 bags of each replications were measure every two or three days or depend on appear of the fruit body. Three randomize mushroom bags among 25 bags in each replications were representative samples to measurement.

Statistical analysis

The data were recorded in MS Excel and analyzed by the General Linear Model option in the Analysis of Variance (ANOVA) program of the Minitab software release 16.1.1, 2010). Sources of variation were treatments and error.

RESULT AND DISCUSSION

Length of mushroom

The lengths of fruiting body were measure every 10 days when mushrooms achieved maturity within two to three days. The matured length was variable during every 10 days measurement but the different length was observed at first, four and sixth times measurements ($P<0.05$). However, the average length of mature fruiting body was not significant different among treatments or level of sawdust ($P>0.05$) (Table 3 and figure 1).

Table 3: Length of mature mushroom use different level of sawdust substrates on the growth and yield of oyster mushroom

Length of mushroom measure every 10 days interval

Treatment	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	AVE
T1	6.08^{ab}	6.50	6.35	6.31^{a}	7.85	7.72^{a}	6.43	6.48	6.95	6.74	6.74
T2	6.73^{a}	7.24	7.02	7.18^{ac}	6.87	6.52^{b}	6.75	6.37	6.98	6.49	6.82
T3	6.73^{a}	6.16	7.82	8.19^{bc}	6.86	6.75^{b}	6.67	6.58	6.62	6.56	6.89
T4	7.07^{a}	6.63	6.97	6.94^{a}	6.99	6.58^{b}	6.67	6.83	6.86	6.92	6.85
T5	5.23^{b}	8.61	7.56	6.86^{a}	7.11	6.27^{b}	6.80	6.97	7.49	7.14	7.00
SEM±	0.306	1.168	0.340	0.276	0.341	0.209	0.276	0.259	0.222	0.242	0.186
Prob	0.005	0.616	0.064	0.004	0.267	0.002	0.898	0.484	0.144	0.350	0.896

^{abc} Means within main effects within rows without common letter are different at $P<0.05$

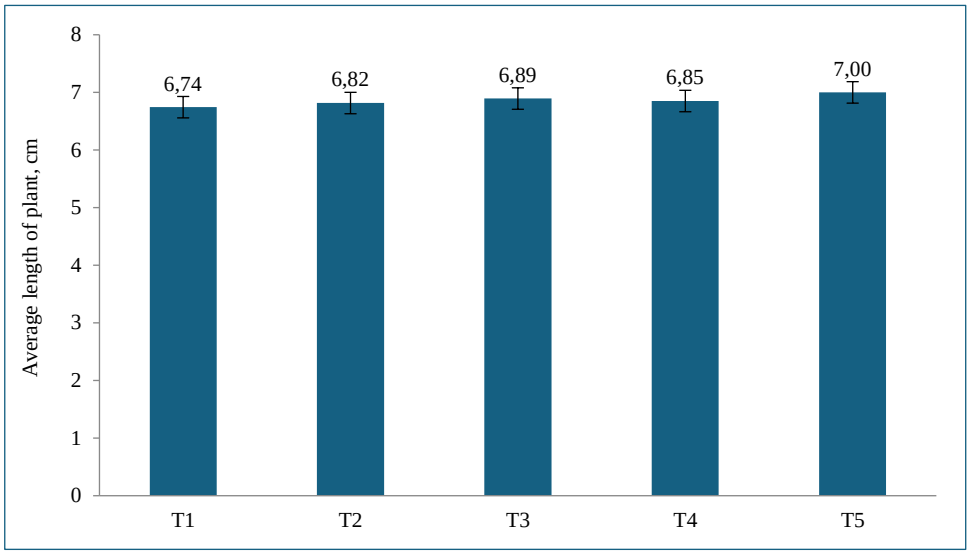

Figure 1: Average length of mature mushroom use different level of sawdust substrates on the growth and yield of oyster mushroom

Diameter of mushroom cap

The diameter of mushroom cap was variable every measurement (Table 4 and figure 2), the different diameter was found when measurement at fourth, fifth, eighth and ninth ($P<0.05$) and other 6 different times (first, second, third, sixth, seventh and tenth) were similar and not significant different ($P>0.05$).However, the average diameter of mushroom cap was trend high for T4 (6.46), T1 (6.40), T3 (6.36) and T2 (6.30) but the lowest was T5 (6.22).

Table 4: Diameter of mushroom cap use different level of sawdust substrates on the growth and yield of oyster mushroom

	Diameter of mushroom leaves measure every 10 days interval										
Treatment	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**AVE**
T1	7.23	5.91	6.39	6.17[a]	7.34[a]	6.36	5.97	6.40[a]	6.07[ab]	6.13	6.40
T2	6.88	6.49	5.91	6.52[a]	6.51[a]	6.21	6.11	6.19[a]	6.23[ab]	5.95	6.30
T3	6.53	6.72	7.01	7.52[b]	6.26[b]	6.06	5.92	5.73[b]	5.93[a]	5.93	6.36
T4	6.36	6.36	6.16	6.76[a]	7.18[a]	5.93	6.49	6.18[a]	6.74[b]	6.37	6.46
T5	5.47	5.64	6.35	6.43[a]	6.45[a]	5.69	6.68	6.12[a]	6.71[b]	6.61	6.22
SEM±	0.434	0.285	0.305	0.296	0.222	0.281	0.265	0.120	0.185	0.188	0.054
Prob	0.104	0.095	0.184	0.052	0.012	0.523	0.227	0.017	0.021	0.098	0.060

[ab] Means within main effects within rows without common letter are different at $P<0.05$

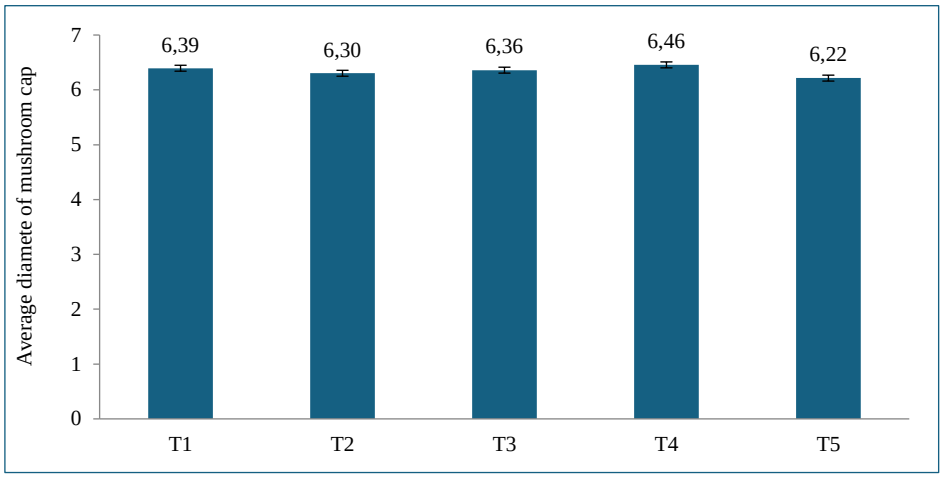

Figure 2: Average diameter of mushroom cap use different level of sawdust substrates on the growth and yield of oyster mushroom

Number of fruit body per packet

The number of fruiting body per packet was significant different among treatments (Table 5 and figure 3) when counting at first, fourth, sixth, seventh, eighth and ninth ($P<0.05$) but it was not significant different when count at second, third, fifth and tenth ($P>0.05$), however, the average number of fruiting body was highly significant ($P<0.001$) with high value in T3 (28.7), T4 (27.6), T5 (27.2) and the lowest were T2 (25.3) and T1(22.3). The number of fruiting body per packet in this study was ranged with study of Ahmed et al (2013) which shows that fruiting body was range from 25.0-34.6. Sarker et al (2007b) reported that the weight of single fruiting body of oyster mushrooms ranged between 1.33–1.59g which lower than that obtained in the present study, which ranged from 3.86-4.90g and ranged with study of Ahmed et al (2013) 2.42 to 7.42 g who use 4 different new strains which suitable to the climatic conditions of Bangladesh, Uddin et al (2011) reported that the environmental condition (average minimum and maximum temperature of 14 to 35°C; relative humidity of 70–80 %) is suitable for the cultivation of oyster mushroom.

Table 5: Number of fruit body per packet use different level of sawdust substrates on the growth and yield of oyster mushroom

	Number of fruit body/packet measure every 10 days interval										
Treatment	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**AVE**
T1	17.2^{a}	21.7	26.0	16.7^{a}	18.2	27.2^{ab}	24.7^{ac}	23.1^{ac}	24.2^{ac}	23.8	22.3a
T2	24.3^{ab}	26.0	17.7	27.1^{b}	24.9	24.7^{a}	26.1^{ac}	26.2^{ac}	27.3^{ac}	28.7	25.3b
T3	32.8^{b}	19.7	23.6	22.3^{ab}	24.6	34.0^{c}	34.7^{b}	34.7^{b}	38.6^{b}	22.5	28.7c
T4	30.6^{b}	26.5	23.7	26.6^{b}	26.7	41.6^{b}	27.5^{a}	23.2^{a}	25.8^{c}	24.2	27.6bc
T5	25.2^{ab}	22.5	30.1	28.5^{b}	25.9	24.4^{a}	30.0^{c}	27.8^{c}	28.0^{c}	29.2	27.2bc
SEM±	2.492	2.422	3.311	2.397	2.648	1.834	1.563	1.538	2.699	2.578	0.7354
Prob	0.004	0.265	0.173	0.020	0.217	0.001	0.003	0.001	0.015	0.283	0.001

^{abc} Means within main effects within rows without common letter are different at $P<0.05$

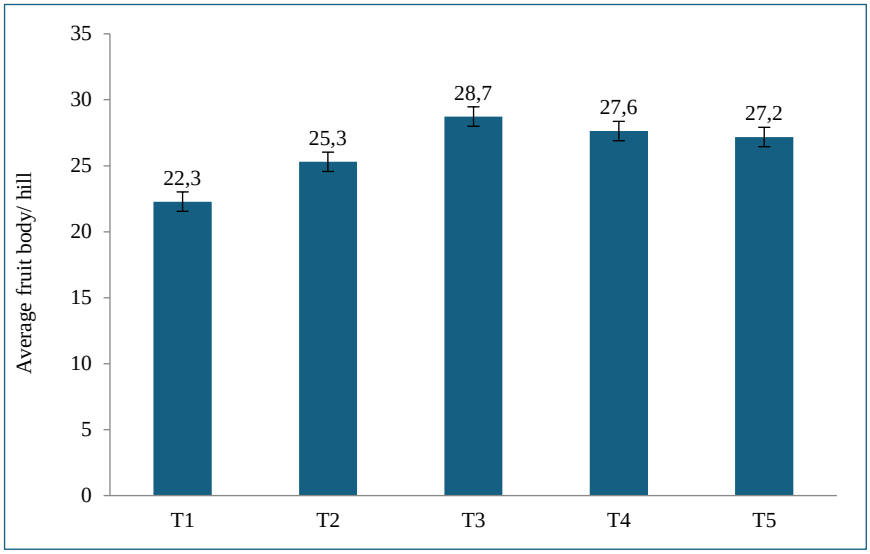

Figure 1: Average number of fruit body per packet use different level of sawdust substrates on the growth and yield of oyster mushroom

Yield of fruit body per packet

The yields of mature fruiting body per packet were variable among treatments and time of measurement and it was not uniform from level of sawdust on the yield production (Table 6 and figure 4). However, the average yield/packet/time was high for T2 (114.2g), T4 (111g), T3 (110.7g) and the lowest was T1 (109.2g) and T (106.9g) but those values were not significant different in statistic (P>0.05). The yield of mushroom per packet in this study was lower than study of Ahmed et al (2013) who study on yield and nutritional composition of oyster mushroom strains newly introduced in Bangladesh showed that the average yield per bag was 164-278g/bag. The different yield might be cause of the study use the standard strain which develop from the Biochemistry Laboratory and Mushroom Culture House of the Department of Biochemistry of Sher-e-Bangla Agricultural University; Dhaka, Bangladesh compared in this present study was not really standard. Pathmashini et al (2008) also recorded that the yield of oyster mushroom was 276.9 g for strain Pleurotus ostreatus in sawdust with kurakkan spawn.

Table 6: The yield of mature fruiting body per packet use different level of sawdust substrates on the growth and yield of oyster mushroom

	The yield of mature fruiting body/packet measure every 10 days interval										
Treatment	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	**8th**	**9th**	**10th**	**AVE**
T1	88.3^{a}	106.6^{ab}	153.9	90.3	123.6^{ab}	110.0^{ac}	128.2^{a}	102.6^{ab}	86.8	101.1	109.2
T2	208.3^{b}	120.9^{a}	97.9	126.6	132.7^{a}	82.7^{b}	88.5^{b}	95.0^{a}	97.7	92.1	114.2
T3	151.8^{abc}	107.8^{ab}	108.9	98.3	90.8^{b}	109.8^{c}	103.9^{b}	130.5^{b}	114.5	90.5	110.7
T4	178.0^{bc}	126.4^{a}	104.3	136.4	88.9^{b}	58.3^{d}	104.8^{ab}	90.9^{a}	109.6	112.5	111.0
T5	116.4^{ac}	79.6^{b}	91.1	137.1	98.5^{ab}	132.8^{e}	104.7^{ab}	131.7^{b}	86.9	90.6	106.9
SEM±	16.98	7.545	15.08	13.94	9.614	5.669	6.323	7.378	7.739	7.312	2.888
Prob	0.001	0.005	0.071	0.088	0.016	0.001	0.009	0.002	0.071	0.201	0.510

^{abcde} Means within main effects within rows without common letter are different at P<0.05

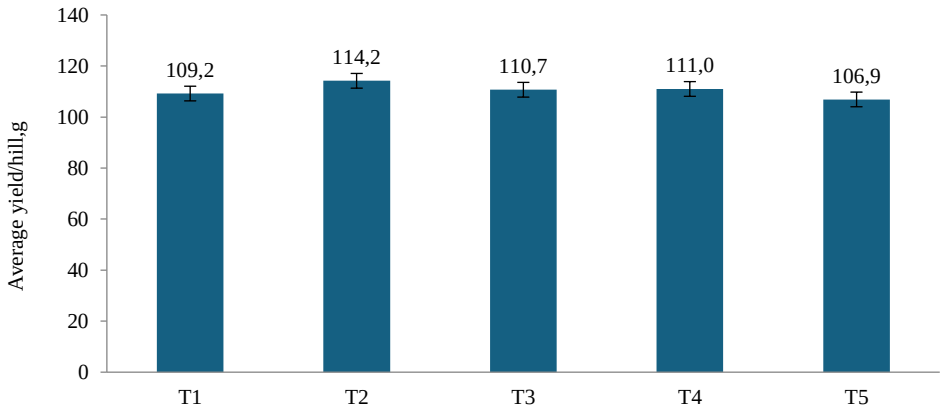

Figure 4: Average yield of mature fruiting body per packet use different level of sawdust substrates on the growth and yield of oyster mushroom

Total yield

The total yield of 25 bags was not significant different for first and third month (Table 20 and figure 32) but except for second month which was significant different (P<0.05) and high value was T3, T2, T4 and lowest was T1 and T5. However, the total yield was trend (P=0.095) high for T4 (8227g), T3 (7257g), T2 (6885g) and the lowest was T5 (5654g) and T1 (5396g).

Table 7: The yield of mature fruiting body for 25 bags use different level of sawdust substrates on the growth and yield of oyster mushroom

Treatment	1st month	2nd month	3rd month	Total yield, g
T1	2160	1960	1276	5396
T2	2562	3114	1209	6885
T3	2840	3313	1104	7257
T4	3554	3209	1464	8227
T5	3002	1386	1267	5654
SEM±	456.8	487.4	128.6	752.2
Prob	0.319	0.044	0.417	0.095

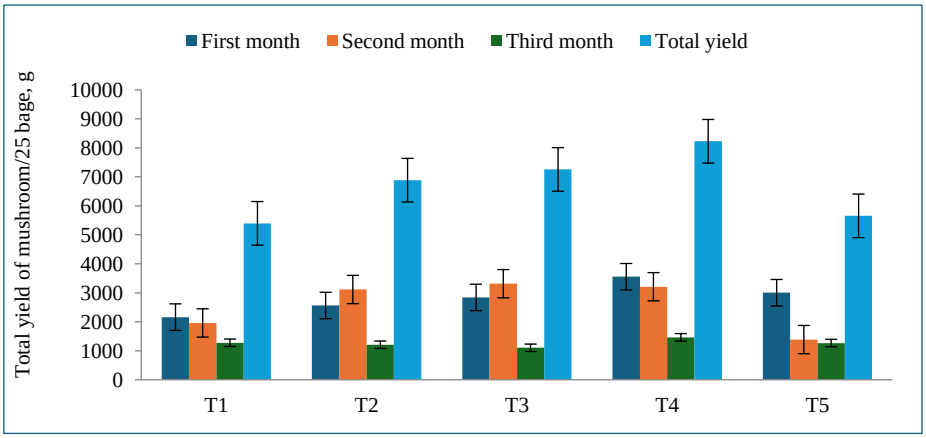

Figure 5: Total yield of mature fruiting body for 25 bags use different level of sawdust substrates on the growth and yield of oyster mushroom

CONCLUSION

Through the experiment we concluded that the length, cap diameter, number of fruit body/packet, yield/packet and total yield in 25 bags were not different among level of sawdust but total yield was better when sawdust used at 80% and substrates from rice husk (25%), rice straw (5%), rice bran (5%) and other element substrates.

Base on the result from the experiment, several recommendations are suggested as follows:

- The research study needs to be improved and deeply study needs to involve the mushroom experts, data recording and cross-check with expert/project leaders to explain a clear protocol for students who involve with the studies. The formulation of treatments should be clear and the total of main substrates should be 100%.
- The time of study should be fixed, particularly for data collection and other measurements. More studies should focus on the evaluation of the influence of locally available substrates containing sawdust of different trees to find the best sawdust among others as substrate for effective cultivation of oyster mushroom.

ACKNOWLEDGEMENT

On behalf of the project team, we would like to express our sincere gratitude to the Royal Government of Cambodia for providing funding support to Svay Rieng University through the Ministry of Education, Youth, and Sport. This generous support has enabled our University to successfully implement the HEQCIP project, which has involved community engagement and student-led experiments in vegetable and mushroom cultivation.

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