Oyster Mushroom (Pleurotus pulmonarius) Production Using Different Substrates Under 27.3°C Average Temperature

1Alifahmie A. Magolama
Assistant Professor IV, College of Agriculture, Mindanao State University- Main Campus
Marawi City, 9700, Lanao del Sur, Philippines

2Sheila G. Griengo
Assistant Professor IV, College of Agriculture, Mindanao State University- Main Campus
Marawi City, 9700, Lanao del Sur, Philippines

3Abdani D. Bandera
Assistant Professor I, College of Agriculture, Mindanao State University- Buug Campus
Buug, Zamboanga Sibugay, 7009, Philippines

Abstract: The study was conducted in an average temperature of 27 ⁰C. Objectives were to determine the yield performance of oyster mushroom using different substrates and substrates’ combination; to determine if there is a significant difference on the yield performance of oyster mushroom using different substrates and substrates’ combination; and to identify which of the different substrates and their combination performs best in oyster mushroom production. The experiment was laid out using Completely Randomized Design (CRD) with an area of 30 m². Four treatments were used and replicated five times. Sawdust, corn cob and rice straw were the substrates used in this study. Treatments were: T₁ (100% rice straw), T₂ (100% corn cob), T₃ (100% sawdust), and T₄ (33.33% rice straw + 33.33% corn cob + 33.33% sawdust). Results of the study showed that there was a highly significant difference on the average number and total number of oyster mushroom during the first harvest. However, the average weight and total weight of oyster mushroom were not significantly different. The average number, average weight, total number, and total weight were not significantly different during the second to fifth harvest. Based on the results of the study, the adoption of T₃ to obtain more number of oyster mushroom per fruiting bag per treatment is highly recommended to improve the production in the locality.

Keywords: Oyster Mushroom; Pleurotus pulmonarius; Complete Randomized Design; Substrate; Corn Cob, Rice Straw, Sawdust.

I. INTRODUCTION

The production of oyster mushroom and other strains is observed high in terms of consumers’ demand in the market. Its nutritive value boosts the demand for the commodity. In addition, the demand for the produce attracts farmers to learn variables affecting mushroom production. However, farmers still struggle in determining appropriate substrates to be used to yield high. Thus, this study helps growers which local substrates is best to improve production.

Mushroom is now found an important commodity due to its nutritive value. [37] reported that Coprinus atramentarius (Bull.; Fr.) Fr. contain 24% of carbohydrate on dry weight basis. The manniotol, also called as mushroom sugar constitutes about 80% of the total free sugars, hence it is dominant [125], [129]. [87] revealed that a fresh mushroom contains 0.9% mannitol, 0.28% reducing sugar, 0.59% glycogen and 0.91% hemicellose. Carbohydrates of Agaricus bisporus were reported by [28]. In mushrooms, the fat content is very low as compared to carbohydrates. The fats present in mushroom fruiting bodies are dominated by unsaturated fatty acids. [118] determined the fat content of some mushrooms as 2.04% in Suillus granulatus, 3.66% in Suillus luteus and 2.32% in A. campestris. [49] found that mushrooms are rich in linolenic acid. Total fat content in A. bisporus was reported to be 1.66 to 2.2/100 g on dry weight basis [78]. [92] showed that mushrooms have 4.48% fats on dry weight basis. [61] has revealed a fat content of 11.52% in the Amanita caesarea fruiting bodies on dry weight basis. In 100 g fresh matter of A. bisporus (Lange) Sing and Pleurotus ostreatus (Jacq; Fr.) Kumm, the content of fatty compounds were reported to be 0.3 and 0.4 g respectively [81], but on dry weight basis, it is 2 and 1.8 g respectively [114], [2], [81], [111] and [82] worked on the fibre content of different mushrooms. Mushrooms are considered good source of fats and minerals [55], [135] and [96] showed that fat fraction in mushrooms is mainly composed of unsaturated fatty acids.

[1] found that content of potassium and sodium in A. bisporus was 300 and 28.2 ppm, respectively. A. bisporus ash analysis revealed high amount of K, P, Cu and Fe [5]. [62] showed that M. esculenta contains Ca (0.5776 mg), P (3.313 mg), Fe (1.213 mg) and K (3.831 mg). [126] showed that A. bisporus contains Ca (0.04 g), Mg (0.16), P (0.75 g), Fe (7.8 g), Cu (9.4 mg), Mn (0.833 mg) and Zn (8.6 mg) per kilogram fresh weight. Mushrooms have been found to accumulate heavy metals like cadmium, lead, arsenic, copper, nickel, silver, chromium and mercury [113], [88], [133], [59], [122], [53], [79]. The mineral proportions vary according to the species, age and the diameter of the fruiting body. It also depends upon the type of the substratum [30]. The mineral content of wild edible
mushrooms has been found higher than cultivated ones [2], [83], [105].

Mushrooms are one of the best sources of vitamins especially Vitamin B [17], [84], [140], [24], [85]. Vitamin content of edible mushrooms has been revealed by [32], [14] and [75]. [80] gave a comprehensive data of vitamin content of mushrooms and some vegetables. [84] pointed out that wild mushrooms contain much higher amounts of vitamin D2 than dark cultivated A. bisporus. Mushrooms also contain vitamin C in small amounts [112], [83] which are poor in vitamins A, D, and E [5].

Lintzel [73]-[74] suggested that 100 to 200 g of mushrooms (dry weight) is required to maintain an optimal nutritional balance in a man weighing 70 kg. [13] identified the nutritive value of Pleurotus flabellatus as 0.974% ash, 1.084% crude fibre, 0.105% fat, 90.95% moisture, 0.14% non-protein nitrogen and 2.75% protein. [8] recommended that food value of mushrooms lies between meat and vegetables. [28] found that mushrooms in general contain 90% water and 10% dry matter. [92] showed that an average mushroom is about 16.5% dry matter out of which 7.4% is crude fibre, 14.6% is crude protein and 4.48% is fat and oil. [41] revealed that edible mushrooms were highly nutritional and compared favourably with meat, egg and milk food sources. Of several thousand mushroom species known worldwide, only around 2000 are considered edible, of which about 20 are cultivated commercially with only 4 to 5 under industrial production [23].

Protein is an important constituent of dry matter of mushrooms [2], [4], [34], [38], [140], [24]. Protein content of the mushrooms has also been revealed to vary from flush to flush [28]. [44] showed that protein in A. bisporus mycelium ranged from 32 to 42% on the dry weight basis. [1] showed 46.5% protein on dry weight basis in A. bisporus. [109] showed 30.16, 28.16, 34.7 and 29.16% protein in dried mycelium of A. campestris, Agaricus arvensis, M. esculenta and Morchella deliciosa respectively. [98] revealed 14 to 27% crude protein on dry weight basis in A. bisporus, Lentinus subnudus, Calocybe indica and Volvariella volvacea. On dry matter basis, the protein content of mushrooms varies between 19/100 and 39/100 g [132], [17]. In terms of the amount of crude protein, mushrooms rank below animal meats but well above most other foods including milk [21]. On a dry weight basis, mushrooms normally contain 19 to 35% proteins as compared to 7.3% in rice, 12.7% in wheat, 38.1% in soybean and 9.4% in corn [28], [72], [10].

[65] showed that mushroom extracts possess DNA protecting properties. G. lucidum extracts can trap number of free radicals [56]. [86] observed antioxidant properties of several ear mushrooms. Many species of mushrooms have been observed to be highly potent immune enhancers, potentiating animal and human immunity against cancer [131], [16], [63], [35]. Tyrosinase from A. bisporus is antioxidant [117]. [69] determined antioxidant activity of P. sajor caju. [106] observed that triterpenoids are the main chemical compounds in G. lucidum. Camptothecin is responsible for antioxidant properties in G. lucidum [139].

In underdeveloped countries where protein malnutrition has taken epidemic proportions, Food and Agricultural Organization has suggested mushroom foods to solve the problem of malnutrition [120], [57] revealed that mushrooms cause regression of the disease state. Mushroom medicines are without side effects [108], [31] showed hundreds of secondary metabolites of fungal origin possessing biological activity. Mushrooms act as biological response modifiers by promoting the positive factors and eliminating the negative factors from the human body and thus regarded as the fourth principal form of the conventional cancer treatment [134]. G. lucidum (Fr.) Karst is believed to act as an antiinflammatory agent [121]; acts as antiadibatic [124]. It is also used by Indian tribes for treating joint pain [45].

[47] revealed various medicinal uses of mushrooms like reishi, cordyceps, enoki, maitake, lion’s mane and splitgill for cancer treatment; shiitake, blazei, reishi, enoki, cordyceps, maitake, mesima and oyster were observed effective against cholesterol reduction. Reishi, cordyceps, shiitake and maitake is used for reducing stress. Lion’s mane has been used for memory improvement; reishi for inducing sleep, cordyceps for physical endurance and sexual performance, reishi, cordyceps, chaga and lion’s mane for asthma and allergy treatment. Shiitake, cordyceps, chaga, shiitake and turkey tail as liver protectants; reishi, maitake, turkey tail and shiitake for treating diabetes. It is also believed to be a good health elevator [89]. Auricularia species were used since times for treating hemorrhoids and various stomach ailments [24]. PSK, an anticancer drug from the mushroom, Coriolus versicolor accounted for 25.5% of the country’s total sales in Japan in 1987 as anticancer drug [24].

Mushroom is indeed an option to substitute expensive commodity which are also rich in nutrients. In addition, due to its cheap production materials, the commodity can be produced easily by local farmers. Thus, the production of the produce is encouraged and considered significant in achieving health and development.

II. MATERIALS AND METHODS

A. Research Design

The experiment was laid out using Completely Randomized Design (CRD) with four treatments. Each treatment was replicated five (5) times. There were three (3) substrates used in the study such as sawdust, corn cob, and rice straw. Randomization was done through drawing of lots. Shown below are the treatments.
The substrates were harvested at the same date to identify differences. The Scheffe method was used to determine which of the different substrates of oyster mushroom would give the highest yield.

### III. RESULTS AND DISCUSSION

#### A. Average Number of Oyster Mushroom per Fruiting Bag per Treatment of H1, H2, H3, H4, and H5

**H1.** Result of the study shows that T3 achieved 33.72, the highest average number of Oyster Mushroom per fruiting bag per treatment, followed by T4 which obtained an average number of 25.88, followed by T1 with the average number of 19.92 and the lowest average number was obtained from T2 (18.84).

**H2.** Result shows that T2 had the highest average number of 17.44, followed by T3 which had the average number of 17.20, followed by T1 with the average number of 16.80 and the lowest average number of 12.40 was obtained from T5.

**H3.** Figure 1 presents the average number of oyster mushroom per fruiting bag per treatment. Result shows that T4 had the highest average number of 18.64, followed by T1 which obtained the average number of 16.60, followed by T2 with the average number of 16.16 and the lowest average number of 16.12 was obtained from T5.

**H4.** Result shows that T1 had the highest average number of 17.68, followed by T3 which obtained an average number of 11.16, followed by T4 with the average number of 10.12 and the lowest average number of 9.88 was obtained from T5.

**H5.** Result shows that T1 obtained the highest average number of 12.64, followed by T3 which achieved the average number of 11.64, followed by T2 with the average number of 8.36 and the lowest average number of 8.12 was obtained from T4.

#### B. Materials

The following materials were used in this study: polypropylene bags clear/ transparent, cotton plug (vonel), piece of paper, rubber band, metallic drum, source of heat (firewood), PVC pipe (1” diameter x 1” long), sprayer, weighing scale, record notebook, ballpen, and calculator.

#### C. Cultural Practices

- **Mushroom House.** An area of 30 square meters was utilized. It was thoroughly prepared with air vents on upper walls to facilitate aeration which was highly needed for the development of fruiting bodies and also served as the light source inside the house. The walls were covered with plastic sheets to provide appropriate humidity needed.

- **Substrates’ Preparation.** The substrates were chopped into small pieces of 1-2 inches except for the sawdust. It was soaked for 24 hours in a drum filled with water and after that, was pulled out from the drum for draining the excess water. The substrates were mixed thoroughly by manual handling.

- **Fruiting Bag Preparation.** The substrates were individually sterilized by steam using metallic drum for 3 hours and allowed to cool to normal temperature.

- **Maintenance.** This was done by a proper and good hygiene before and after spawning to avoid contamination and to prevent the adverse attack of pest. Close monitoring of the crop on a daily basis was done to prevent pests’ infestation and diseases infection.

- **Harvesting.** Four days after opening the fruiting bags, mushroom was ready for harvest. Mushrooms were picked at the bottom, cup or flat stage depending on the market requirements. The fruiting bodies were harvested by hand with a twisting motion.

#### D. Data Gathering Procedures

All fruiting bags per treatment were considered as the sample. The oyster mushroom from the four treatments were harvested at the same date to identify yield differences. The data collected were the following:

- **Average Number of Oyster Mushrooms per Fruiting Bag per Treatment.** The average number of oyster mushrooms per fruiting bag per treatment was added and divided by the total number of sample bags per treatment.

| Treatments | Description                                      |
|------------|--------------------------------------------------|
| T1         | =100% rice straw                                 |
| T2         | =100% corn cob                                   |
| T3         | =100% sawdust                                    |
| T4         | =33.33% rice straw + 33.33% corn cob + 33.33% sawdust |

*Definition (T)

Table 1

Average Weight of Oyster Mushroom per Fruiting Bag per Treatment (in grams). The average weight of oyster mushroom in grams per fruiting bag per treatment was weighed using the weighing scale and it was added to get the total weight and divided by the number of sample bag per roped bag per treatment.

Total Number of Mushrooms per Fruiting Bag per Treatment. The total number of mushroom per roped bag per treatment was counted and it was added to get the sum.

Total Weight of Oyster Mushrooms per Fruiting Bag per Treatment (in kilogram). The total weight of oyster mushroom per fruiting bag per treatment was weighed using the weighing scale and it was counted and added to obtain the total weight.

#### E. Data Analysis

Analysis of Variance (ANOVA) for Completely Randomized Design (CRD) were used as tool in determining the results of the study. The Scheffe method was used to determine which of the different substrates of oyster mushroom would give the highest yield.
shows that T
mushroom in grams per fruiting bag per treatment.

B. Average Weight of Oyster Mushroom in Grams per Fruiting Bag per Treatment.

H1. Figure 2 shows the average weight of oyster mushroom in grams per fruiting bag per treatment. Result shows that T1 obtained the highest average weight of 102 grams, followed by T2 which obtained the average weight of 96 grams, followed by T3 with the average weight of 94 grams and the lowest average weight of 90 grams was obtained from T1.

H2. Result shows that T4 achieved the highest average weight of 98 grams, followed by T3 which obtained the average weight of 92 grams, followed by T1 with the average weight of 90 grams and the lowest average weight of 84 grams was obtained from T2.

H3. Result showed that T4 obtained the highest average weight of 98 grams, followed by T1 which achieved the average weight of 92 grams, followed by T3 with the average weight 90 grams and the lowest average weight of 84 grams was obtained from T2.

H4. Figure 2 revealed the average weight of oyster mushroom in grams per fruiting bag per treatment. Result showed that T1 obtained the highest average weight of 100 grams, followed by T2 which obtained the average weight of 94 grams, followed by T4 with the average weight of 92 grams and the lowest average weight of 80 grams was obtained from T3.

H5. Result showed that T1 obtained the highest average weight of 106 grams, followed by T2 which obtained the average weight of 94 grams, followed by T3 with the average weight of 80 grams and the lowest average weight of 70 grams was obtained from T4.

C. Total Number of Oyster Mushroom per Fruiting Bag per Treatment.

H1. Figure 3 presents the total number of oyster mushroom per fruiting bag per treatment. T1 obtained the highest number with a total of 803, followed by T4 which obtained a total of 548, followed by T1 with a total number of 498 and lowest total number of Oyster Mushroom was obtained from T2 having 471.

H2. Result shows that T3 obtained the highest number with a total of 450, followed by T2 which obtained a total of 436, followed by T1 with a total number of 435 and the lowest number was obtained from T4 having 367.

H3. Result of the study shows that T4 obtained the highest number with a total of 540, followed by T2 which obtained a total of 500, followed by T3 which obtained a total of 480 and the shorter number of total was obtained from T4 having a total of 450.

H4. Figure 3 presents the total number of oyster mushroom per fruiting bag per treatment. It revealed that T1 obtained the highest number with a total of 317, followed by T2 which obtained a total of 279, followed by T4 which obtained a total of 264 and shorter number of total was obtained from T3 having 236.

H5. Result of the study showed that T1 obtained the highest total number with a total of 316, Followed by T3 which obtained a total number of 259, followed by T4...
which obtained a total number of 235 and the lowest total number was obtained from T3 having 209.

D. Total Weight of Oyster Mushroom in Kilograms per Fruiting Bag per Treatment.

H1. Figure 4 presents the total weight of oyster mushroom in kilogram per fruiting bag per treatment. Figure 4 shows that T1 obtained the heaviest total weight of 2.30 kg, followed by T4 with 2.25 kg, followed by T2 with the total weight of 2.10 kg, and the lowest total weight of 2.00 kg was obtained by T4.

H2. Figure 4 shows that T1 obtained the heaviest total weight of 2.55 kg, followed by T2 and T4 with a total weight of 2.35 kg. Whereas, T1 obtained the lowest total weight among the four treatments having 2.25 kg.

H3. Result of the study reveals that T2 and T4 obtained the heaviest total weight of 2.50 kg, followed by T3 with a total weight of 2.40 kg. Whereas, T1 obtained the lowest total weight among the four treatments having 2.25 kg.

H4. Result shows that T1 obtained the heaviest total weight of 2.50 kg followed by T4 with a total weight of 2.30 kg, followed by T2 with the total weight of 2.20 kg and the lowest total weight among the four treatments having 2.05 kg was obtained from T3.

H5. Figure 4 presents the total weight of oyster mushroom in kilogram per fruiting bag per treatment. Result shows that T1 obtained the heaviest total weight of 2.65 kg, followed by T2 with a total weight of 2.35 kg. On the other hand, T3 and T4 obtained the lowest total weight among the four treatments having 1.90 kg.

Fig 4:– Total Weight of Oyster Mushroom in Kilograms per Fruiting Bag per Treatment from H1 to H5

IV. CONCLUSION

Based on the result and analysis of the study, the following conclusions were drawn:

There was a significant difference on the average number of oyster mushroom per fruiting bag per treatment and total number of oyster mushroom per fruiting bag per treatment. However, there were no significant differences on the average weight in grams per fruiting bag per treatment and total weight in kilogram per fruiting bag per treatment for H1.

There were no significant differences on the average number of oyster mushroom per fruiting bag per treatment for H2, H3, H4 and H5.

There were no significant differences on the average total weight of oyster mushroom in grams per fruiting bag per treatment for the H2, H3, H4 and H5.

There were no significant differences on the total number of oyster mushroom per fruiting bag per treatment for the H2, H3, H4 and H5.

RECOMMENDATIONS

Based on the previous findings and conclusions, the following are recommended:

- The adoption of T1 to obtain more number of oyster mushroom per fruiting bag per treatment.
- To have a significant yield of oyster mushroom, the adoption of T1 is recommended.
- The use of rice straw and sawdust as substrates to gain more yield on the performance of Oyster Mushroom is also recommended.

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