PRODUCTION TECHNIQUE OF OYSTER MUSHROOM ON COMPOSTED SAWDUST BASED SUBSTRATES

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Dedicated to
my beloved daughter
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CERTIFICATE

*This is to certify that the thesis entitled " **PRODUCTION TECHNIQUE OF OYSTER MUSHROOM ON COMPOSTED SAWDUST BASED SUBSTRATES**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in HORTICULTURE**, embodies the results of a piece of bonafide research work carried out by **NUSRAT JAHAN NISHI**, Registration No. **14-06125** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information as has been availed of during the course of this investigation has duly been acknowledged.

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ABSTRACT

The experiment was carried out in the laboratory of the Mushroom Development Institute, Savar, Dhaka from July 2019 to December 2019 to determine the effect of the sawdust composting period on the yield and yield attributes of different oyster mushroom varieties. The experiment was laid out in Completely Randomized Design (CRD) with three replications. There were two factors in this experiment. Factor A: Variety, V_1 (*Pleurotus djamor*), V_2 (*Pleurotus ostreatus* PO10) and V_3 (*Pleurotus florida)* and Factor B: Days of composted sawdust, T_0 (0 days), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days) and T_6 (30 days). In the study, the highest number of the fruiting body (13.97), number of the effective fruiting body (11.43) and the highest biological yield (50.12 g) was found in V_2 whereas, the lowest number of total fruiting body (4.36), effective fruiting body (2.54) and biological yield (11.43) was observed in V_3. Results revealed that the maximum yield (55.00 g), the highest number of fruiting bodies (11.57) and effective fruiting body (9.21) were observed in T_3. The combined effect of different mushroom varieties and composted period of sawdust showed a notable variation in biological yield. The maximum yield (56.50 g) was produced by V_2T_3 and the minimum yield (38.13g) was produced by V_3T_2. The highest biological efficiency was obtained in V_2T_3 which was 32.28 % whereas, the lowest biological efficiency was obtained in V_3T_2 sawdust which was 21.78%. This study suggests that *Pleurotus ostreatus* and 15 days composted sawdust showed the best performance among the planned treatments of the research in most of the cases.

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CHAPTER I

INTRODUCTION

Mushrooms are classified as heterotrophic organisms which get their food from decaying materials or other living things. It has a fleshy and spore-bearing fruiting body and belongs to the class Basidiomycetes under the order Agaricales in fungal classification. Mushroom, a highly-priced delicacy for more than two thousand years, is now consumed by many people due to its delicious taste, flavor, dietetic qualities and several medicinal properties (Martínez-Ibarra *et al*. 2019; Kakon and Choudhury 2015 and Ngethich *et al*. 2013). The fresh mushroom contains about 85-90% moisture, 3% protein, 4% carbohydrates, 0.3-0.4% fats and 1% minerals and vitamins. It has also shown some medicinal properties like anti-inflammatory, antiviral, cholesterol-reducing, and immune-enhancing properties, as well as helping to reduce blood pressure and blood sugar levels. Consumption of mushrooms was found to be associated with a lower risk of heart disease (Miah *et al*. 2017). Edible mushrooms are also rich in vitamins such as vitamin B, C, and D, vitamin B_1 (thiamine), vitamin B_2 (riboflavin), niacin and provitamin D_2 (ergosterol) (Ahmed *et al*. 2009).

Widespread malnutrition with the increased protein gap in Bangladesh has necessitated an alternative source of protein. Animal protein is beyond the reach of most people in this country because about 21.8 percent population lives under the poverty line (BBS 2017). According to research, almost all the arable area of the country is already under cultivation, there is limited scope for expanding the cropland and cropping intensity. Food And Agricultural Organization has recommended edible mushrooms as a source of protein nutrition of developing countries depending largely on cereals for (FAO 2000).

There are 14,000 species of mushrooms including 2000 species that are considered to be edible. The oyster mushroom (*Pleurotus* spp) is the third place after the white button and shiitake among the world mushroom production (Gyorfi *et al*. 2007). Oyster mushroom belongs to the genus *Pleurotus*, which is a diverse group of twenty-five species of saprotrophitic fungi such as *P. columbinus, P. flabellatus, P. florida, P. djamor, P. florida, P. ostreatus, P. ostreatus* and *P. sajor-caju*. Culture of oyster mushroom is becoming popular throughout the world due to the utilization of various lignocellulose species having extensive enzyme systems capable of complex organic compounds that occur as agricultural wastes and industrial by-products. Oyster mushroom is most suitable for year round production in Bangladesh for wide range of temperature and different agro wastes available as growing media, lower production cost in our country. The biological efficiency of this mushroom is about 100%. The popularity of these mushrooms is increasing day by day because of nutritional value that could alleviate the deficiency of proteins and their possible antimicrobial activity. Thus, the increased production of oyster mushrooms presents a feasible solution to malnutrition experienced in most developing countries like Bangladesh.

Oyster mushroom species, unlike button mushrooms (*Agaricus bisporus*), are primary decomposers (Mohamed *et al*. 2014). Oyster mushroom cultivation can play an important role in managing organic wastes disposal has become a problem (Das and Mukherjee 2007). Any agriculture waste that contains cellulose and lignin is possible substrate for growing these fungi. Reports on the cultivation of mushroom on solid substrates such as sawdust and different agricultural wastes such, sugarcane bagasse, rice husks, coconut fiber, peanut hulls, banana leaves etc. can be used as a substrate for growing mushroom (Gupta 1986). Furthermore, the appropriate preparation of the substrate is crucial for the production of the maximized yield of Oyster mushrooms (Choi *et al*. 2009; Obodai and Johnson 2002; Soliman 2011). Cereal bran rich in protein is usually added to the substrate in Oyster mushroom cultivation to stimulate mycelial growth and increase the yield of mushroom (Kinugawa *et al*. 1994). Sawdust and sugarcane bagasse were the best substrates for growing of Oyster Mushroom than other agro-based substrates (Ahmed 1998). In Bangladesh, sawdust is produced in a large scale by the saw-mill industries as a byproduct. As a result, it is readily available and sawdust is commonly used and is the preferred medium at a commercial scale.

However, it has been found that fermented substrate materials produce high yield and quality fruiting bodies (Choi 2004). In a previous study, Block *et al*. (1958) made sawdust compost, corn cob-hay compost and sawdust-hay compost for the cultivation of *Agaricus campestris* and *P. ostreatus* and results suggest that good yields was produced from composted sawdust in *P. ostreatus*. As shown by (Obodai and Johnson 2002), composted Triplochiton scleroxylon sawdust mixed with other substrates significantly increased the yield of *P. ostreatus*. Dada and Fasidi (2018) demonstrated that increasing yield and mushroom sizes can be obtained from experimental production on sawdust composed, due to sawdust is partial degradation and makes the wood fibre which occurs during composting sawdust more easily digested by mushrooms. But, the aged of composted sawdust that would give best growth and high yield of deferent mushroom species has not been established yet. Additionally, if the right composting time will be established for mushroom variety the efficiency of the production of mushroom can be promoted. Thus the total production would increase by fulfilling the local market demand. Grower can export it and earn foreign currency. Considering the present situations and above facts the present investigation was undertaken with the following objectives:

Objectives

- To find out the best species for ensuring the maximum yield of oyster mushrooms.
- To investigate the effect of the composting period on mycelium growth and yield of the oyster mushrooms
- To find out the appropriate combination of the composting period with oyster mushroom species on the yield of oyster mushroom.

CHAPTER II

REVIEW OF LITERATURE

Pal *et al*. (2020) investigated the suitability of locally available substrate Eleusine coracana (finger millet) straw for the cultivation of different Pleurotus species in terms of yield, biological efficiency, nutritional content, and antioxidant properties in Tawang, Arunachal Pradesh's native conditions. They successfully cultivated four species of oyster mushroom namely *Pleurotus florida*, *P. ostreatus*, *P. citrinopileatus* and *P. erygnii* on finger millet straw in the native condition of Tawang. They found *P. florida* and *P. ostreatus* showed better results in terms of pin head appearance, fruiting bodies maturation, yield and biological efficiency when compared ($P \leq 0.05$) to *P. citrinopileatus* and *P. erygnii*.

Paudel and Dhakal (2020) conducted a research to know the Yield performance of oyster mushroom (*Pleurotus ostreatus*) on different substrate. They used five different substrates namely rice straw, maize husks, banana leaves, finger millet husk and mixture of rice straw and black gram pod shell (1:1). They revealed finger millet husk completed earlier spawn run (18.57 days), highest total quantity yield (1024.57g/bag) while rice straw (956.14g/bag) with corresponding biological efficiency 178.19% and 166.29%, respectively gave significantly higher performance. They also found that the cropping duration was significantly higher in maize husks and banana leaves as compared to rest of three treatments viz., finger millet husk, rice straw and mixture of rice straw and black gram pod shell (1:1). Finally they concluded that the biological efficiency and earliness of crop the performance was maximum in finger millet husk, followed by rice straw.

Jamil *et al*. (2019) experimented at Rawalakot, Azad Jammu, and Kashmir, Pakistan, to evaluate the acceptability of various substrates without the use of supplements. On readily available substrates, three separate oyster mushroom species, *P. sajor-caju*, *P. sapidus*, and *P. erynjii*, were grown. They discovered that *P. sapidus* had the best results in terms of the number of days necessary to complete a spawn run, the appearance of pinheads, and the development of fruiting bodies. *P. sapidus*, on the other hand, had the highest number of fruiting bodies, yield, and biological efficiency. In fine they concluded that *P. sapidus* can be spawned for better yield of oyster mushrooms under temperate climatic conditions.

Dada and Fasidi (2018) investigated the influence of compost fermentation (long and short composting) on the fruit body of *Pleurotus ostreatus* using agricultural wastes such as sawdust. They discovered that as the number of days after inoculation rose, substantial increases were obtained for long composted (35 days) and short composted (9 days) substrates, as well as the control. When compared to uncompensated substrate, long composted substrate (35 days) generated larger fruit bodies with a considerable increase in the quantity of healthy fruiting bodies (control). The number of healthy fruit bodies was lowest on the short composted substrate (9 days), but there was no significant difference when compared to the control. They showed that experimental sawdust production can increase yield and mushroom size.

Miah *et al*. (2017) experimented to see how different sawdust substrates, such as Magiferaindica (Mango tree, T_1), Albizia saman (Raintree, T_2), Tectona grandis (Segun tree, T_3), Gmelina arborea (Gamari tree, T_4), Swietenia mahagoni (Mahogony tree, T_5), and a mixture of all five trees saw (white oyster mushroom). They discovered that T_5 had the highest average number of fruiting bodies (57.20), biological yield (227.68 g), economic yield (207.58 g), benefit-cost ratio (BCR) (4.25) and dry matter content (14.16 percent) than other treatments. Finally they concluded that the sawdust T_5 (Mahogony sawdust) performed significantly better on growth, yield, and nutrient content of white oyster mushroom compare to the other sawdust used in this study.

Mohamed *et al*. (2016) evaluated the production of *Pleurotus columbinus* mushroom fruiting bodies on various formulations of rice or maize straw substrates mixed at various percent with the equivalent composted straw. The formulations were : (1) raw straw (RS) mixed with 5% composted straw (CS), (2) RS mixed with 10% CS, (3) RS mixed with 15% CS, (4) RS mixed with 25% CS, (5) RS combined with 50% CS, and (6) 100 percent RS. Moisturized chopped RS was mixed with chicken manure and soil (4:1:1, v/v) to make composted straw (CS). They discovered that the substrate had a significant impact on the quantity and features of oyster mushroom fruiting bodies. Fruiting body yield, biological efficiency, earliness for pinhead formation, fruiting body cap diameter, thickness, and weight, and stem diameter, length, and weight were all higher in the formulation containing 15% CS. In comparison to solo RS, there was a rise of up to 80% in fruiting bodies crop outcome. The researcher reveals that composted straw substrates have a lot of promise for the Pleurotus mushroom industry's growth.

Akter (2015) conducted an experiment in the Mushroom Development Institute in Savar, Dhaka to assess the influence of spawn age on yield and yield parameters of various oyster mushroom species. Four varieties of mushroom i.e. V_1 (*Pleurotus djamor*), V_2 (*Pleurotus ostreatus* var. white snow), V_3 (*Pleurotus ostreatus*), V_4 (*Pleurotus salmoneostramineus*) with seven types of the age of spawn T_1 (1 day old), T_2 (5 days old), T_3(10 days old), T_4 (15 days old), T_5 (20 days old), T_6 (30 days old) were used as treatment. The highest yield was supplied to all kinds at 1 day of spawn age and the minimum yield was supplied at 30 days of spawn age. V_1, V_2, V_3, and V_4 yielded the highest yields of 135.3g/500g packet, 111.5 g/500g packet, 126.5 g/500g packet, and 137.0 g/500g packet at one day old of spawn, respectively, whereas V_1T_7 yielded the lowest yield of 41.00 g/500g packet. They concluded that the *Pleurotus salmoneostramineus* variety with one-day-old spawn gave the best combination for mushroom development.

Lucky (2015) conducted this experiment at the Mushroom Development Institute's Tissue Culture Laboratory and Culture House in Savar, Dhaka. She used two treatment – (1) varieties, viz. V_1 (*Pleurotus ostreatus*) and V_2 *(Pleurotus djamor*) and (2) nine different Substrates ratio S_1 (25% straw + 10% paddy grain (mother culture) + 65%sawdust), S_2 (35% straw + 10% paddy grain (mother culture) + 55% Sawdust),S_3 (45% Straw + 10% paddy grain (mother culture) + 45% Sawdust), S_4 (55%Straw + 10% paddy grain (mother culture) + 35% Sawdust), S_5 (65% Straw +10% paddy grain (mother culture) + 25% Sawdust), S_6 (75% Straw + 10% paddy grain (mother culture) + 15% Sawdust), S_7 (85% Straw + 10% paddy grain (mother culture) + 5% Sawdust), S_8 (90% Straw + 10% paddy grain(mother culture), S_9 (90% Sawdust + 10% paddy grain (mother culture). They discovered that *Pleurotus ostreatus* had the largest yield (66.50 g), highest number of fruiting bodies (16.53), and the most effective fruiting bodies (12.11). They also showed that mother culture+ 45% Sawdust had the maximum number of fruiting bodies (15.25), effective fruiting bodies (12.11), and yield (63.25). Finally, they reported that *Pleurotus ostreatus with* mother culture+ 45% Sawdust provided the highest yield (90.00 g) while V_2S_6 provided the lowest yield (21.00 g).

Ashrafi *et al*. (2014) conducted a study to reuse oyster mushroom SMS for oyster mushroom cultivation at Bangladesh Agricultural University (BAU), Mymensingh. Two mushroom species (*Pleurotus ostreatus* and *Pleurotus florida*) were cultivated on SMS with varied concentrations of sawdust and wheat bran. For both *P. ostreatus* and *P. florida*, the results revealed that SMS supplementation with 60% sawdust + 20% wheat bran produced the maximum biological yield, economic yield, and biological efficiency. The study concluded that supplementing discarded mushroom substrate and reusing it can be a suitable solution to the disposal problem, while augmented SMS can be an excellent substrate for mushroom cultivation.

Bhattacharjya *et al*. (2014) investigated the cultivation of *Pleurotus ostreatus* on a variety of sawdust substrates, including *Ficus carica* (Fig tree, T_2), *Albizia saman* (Rain Tree, T_3), *Swietenia mahagoni* (Mahogany tree, T_4), *Leucaena leucocephala* (Ipilipil tree, T_5), *Eucalyptus globul.* T_4 had the fastest mycelium growth rate (0.70 cm/day) and the shortest time from primordial initiation to harvest (3.33 days). T_1 had the shortest time from stimulation to primordial initiation (8.00 days), highest biological yield (373.4 g/packet), highest economic yield (371.8 g/packet), dry yield (37.16 g/packet), biological efficiency (213.2%), benefit-cost ratio (5.62), highest average number of primordia/packet (226.3), highest average number of fruiting bodies/packet (122.3), highest average weight of the individual fruiting body (4.45 g), and highest average number of effective fruiting bodies (4.45 g). T_3 was determined to be the greatest substrate for mushroom formation, with a biological output of 373.4 g/packet and biological efficiency of 213.2 percent, followed by T_1, T_4, T_6, T_5, and T_2.

Biswas (2015) studied the growth, yield, and proximate composition of oyster mushrooms using five distinct sawdusts: mango tree, rain tree, teak tree, the mahogany tree, and a blend of all four sawdusts supplemented with 30% wheat bran and 1% CaCO3 as a basal substrate. Mango tree sawdust had the highest mycelium running rate in the spawn packet (0.72 cm/day), the longest period from stimulation to primordial initiation (8.04 days), and the shortest time from primordial initiation to harvest (4.24 days), maximum number of primordial/packet (217.5), fruiting body/packet (115.5), effective fruiting body/packet (29.02), largest weight of individual fruiting bodies (5.60 g), dry yield (35.15 g), biological yield (368.18 g), and economic yield (360.68 g). The oyster mushroom had the maximum moisture content (89.13 percent) in mahogany tree sawdust. They concluded that mango tree sawdust combined with 30% wheat bran can be utilized as a better substrate for oyster mushroom production, lowering costs and boosting productivity.

Nusrat *et al*. (2014) investigated the best conditions for mycelial growth and the phylogenetic relationships of selected *Pleurotus florida* strains. The optimal temperature for mycelial growth was determined to be 25°C, and the minimum temperature for mycelial growth was discovered to be 10°C. For mycelial growth, this mushroom has a wide pH range, with pH 6 being the most beneficial.

Chukwurah *et al*. (2013) investigated the performance of *Pleurotus ostreatus* by examining the stipe length, pileus breadth, and stipe girth of oyster mushrooms cultivated on various farm surfaces. The farm substrates (treatments) were made up of a variety of agricultural wastes mixed with lime and water as additives. Mushrooms grown with substrates made of two different types of agricultural wastes had higher mean values of stipe length, ileus breadth, and stipe girth, while those produced in a substrate made of a single agricultural waste had lower values. The association between biological efficiency and pileus breadth had the highest coefficient of determination. The substrate built from maize cob and palm kernel cake have the best biological efficiency (97.9%). They suggested that farm substrates made up of two separate agricultural wastes be used.

Moonmoon *et al*. (2013) investigated the performance of seven oyster mushroom varieties, including *Pleurotus ostreatus* (PO-2), *Pleurotus ostreatus* (WS), *Pleurotus ostreatus* (POP-1 & POP-2), *Pleurotus salmoniostraminus* (PSS), and *Pleurotus florida* (FLO-1 & FLO-2), in five places including Dhaka, Dinajpur, Rangamati, Faridpur. They found that the treatment combination Savar and PO-2 need for the shortest time required from opening to harvesting (2.67 days) and maximum in Savar and PSS for number of fruiting bodies (51.75). The strain PSS produced the highest yield (151.30g) and biological efficiency (75.63%) in Dinajpur, followed by Dinajpur and POP-2.

Pleurotus ostreatus was grown on a variety of substrates, including rice straw, rice straw + wheat straw, rice straw + paper, sugarcane bagasse, and alder sawdust, according to Sharma *et al*. (2013). Apart from rice straw, all substrates were supplemented with 10% rice bran. The control was the substrate without the supplement. Different substrates were tested for their effects on mycelial development, colonization time, primordial appearance time, mushroom yield, biological efficiency (BE), mushroom size, and chemical composition. Rice straw (control) was shown to be the best substrate for mushroom cultivation, with yield (381.85g) and BE (95.46%), followed by rice + wheat straw and rice straw + paper waste. The nutritive value of mushroom fruit cultivated on rice straw was likewise superior.

Singha *et al*. (2013) investigated the performance of eight distinct *Volvariella volvaceae* strains, namely VV-1, VV-2, VV-3, VV-4, VV-5, VV-6, VV-7, and VV-8, for acceptable vegetative development, yield, and yield contributing features. They showed VV-4 (8.55 days) and VV-1 (22.75 days) need the most days for completing the mycelial growth, VV-6 for the greatest length (3.83 cm) and diameter (2.20 cm) of fruiting bodies, VV-5 strain of *V. volvaceae*for highest biological yield (1045.10 g) and biological efficiency (26.13 %). They suggested that the VV-5 strain of *V. volvaceae*strain is appropriate for commercial production in Bangladesh.

When trying two techniques of pasteurizing substrates (axenic verses composting/steam pasteurization) for the growth of three species of Pleurotus, Siqueira *et al*. (2012) composted bean straw for 7 days with a turning interval of 2 days. In comparison to *P. eryngii*, he found that *P. ostreatus* and *P. pulmonarius* performed well in both pasteurization procedures.

Moonmoon *et al*. (2012) investigated the performance of 23 oyster mushroom types to find the best type and substrate during the summer season in Bangladesh. They found Po-10 planted on rice straw followed by sawdust produced the maximum yield (235.0 g/packet), number of fruiting bodies (50.3), and pileus diameter (5.75 cm) of all the types but Pcys-1 had the largest diameter of stalk and pileus thickness (4.10 cm). On the other hand Po-4 cultivated on sawdust took the most days (33.75) to finish mycelium running, while Po-8 on rice straw had the most pileus thickness (0.26 cm). Finally the showed that the strain Po-10 planted on both substrates may be grown during the summer season in Bangladesh, based on yield and yield qualities.

For oyster mushroom production, diverse substrates require various composting times. Markson *et al*. (2012) composted sawdust for thirty (30) days and turned it regularly at seven-day intervals when evaluating the growth support potential of different substrates for the cultivation of mushroom; however, the rest of the substrates, such as coconut coir, banana leaves, and dead palm trunk, were simply soaked in water for 12 hours. Following the experiment, he found that palm trunk fiber and coconut coir did not support the growth of the test mushroom, citing the acidity level of those substrates as the explanation.

In the National Mushroom Development and Extension Centre, Savar, Dhaka, Bangladesh, Howlader *et al*. (2011) evaluated the performance of several strains of *Pleurotus cystidiosus* (Pcys). They showed that Pcys-4 had the fastest mycelial growth (0.58cm/day), Pcys-1 produced the highest biological (196.3g/packet), economic yields (189.0 g/packet), effective fruiting bodies (37.25), longest stipe length (4.95cm) and pileus thickness (1.35cm) while Pcys-6 had the largest weight of individual fruiting bodies (26.88 g). They concluded that Pcys-1 had the highest biological efficiency (BE).

Wood ear mushrooms (*Auricularia auricula*L.) were grown on composted and non-composted agro-wastes in an experiment by Onyango *et al*. (2011). They used maize cobs, sawdust, sugarcane bagasse grass straw, and wheat straw supplemented with wheat or rice bran at 80:20 ratio. They found nutritional value of maize cobs and wheat bran having higher cellulose, crude protein, and moisture content. On composted maize cobs treated with wheat bran, the dark brown strain had considerably ($p = 0.05$) greater production factors. They concluded that sawdust and rice bran had the lowest growth performance of all the strains.

Uddin *et al*. (2011) stated that though Oyster mushrooms (*Pleurotus* spp.) are commonly cultivated all over the world but environmental factors such as temperature and relative humidity have a significant impact on its formation. *Pleurotus ostreatus, Pleurotus florida, Pleurotus sajor-caju*, and *Pleurotus leurotu*s high king were cultivated in Bangladesh during each season (January to December). They stated that lowest days necessary for primordial initiation, the maximum number of fruiting bodies, biological yield, and biological efficiency were all found throughout December to February in all of the species studied (14-27^{0}C, 70-80% RH) while the cultivated season of August to October, the yield was found to be at its lowest. They recommend that *Pleurotus spp.* grown best in thewinter.

An experiment was carried out by Hasan *et al*. (2010) at Khulna University's Microbial Biotechnology Laboratory of the Genetic Engineering and Biotechnology Department. They investigate mushroom growth and yield using twelve different lime treatments. Rice straw + 10% poultry litter + 1% lime had the best yield (119gm) and return (12.85Tk) of all the treatments. In the treatment of banana leaf midribs + 10% horse dung + 1% lime, the greatest mycelium running rate was recorded. In banana leaf midribs + 10% cow dung + 1% lime, the shortest time of mushroom formation was discovered. They discovered that rice straw + 10% poultry litter +

1% lime and rice straw + 10% horse dung + 1% lime were the most effective and economically viable treatments for cultivating oyster (*Pleurotus ostreatus*) mushrooms.

Mondal *et al*. (2010) researched in the mushroom cultivation laboratory at the Horticulture Center in Khairtala, Jessore, to assess the better performance of the oyster mushroom *Pleurotus florida* in various substrate compositions and to determine the best substrate for mushroom cultivation. They found that banana leaves and rice straw had the highest mycelium running rate (1:1), but that control had the lowest. Banana leaves and rice straw had the shortest mycelium running time (1:3 and 3:1). The number of total primordia and effective primordia was found to be maximum in the control group, although the maximum pileus thickness was measured in rice straw. Rice straw produced the highest biological and economic yields (164.4 and 151.1 g, respectively), which was significantly greater than the control. From a graphical standpoint, both positive and negative connections between economic yield and other yield contributing factors were discovered.

Shelly *et al*. (2010) evaluated ten different oyster mushroom species that were grown on rice straw. They found *Pleurotus erryngi* and *Pleurotussajor-caju*had the longest DRSPI (10.25). *Pleurotus citrinopileatus* for shortest days for stimulation to first harvesting (DRSFH) (5.50), but the Pleurotuscitrinopileatus showed the most effective fruiting bodies (47.00). They also stated that *Pleurotus erryngi* had the longest stipe (6.80cm), largest stipe (4.60 cm) and pileus (11.00 cm) diameters. Finally they showed that *Pleurotus ostreatus* had the highest biological and economic yields and biological efficiency, with 191.00g and 183.5g and 127.30 %, respectively.

Between July 2000 and May 2001, Islam *et al*. (2009) conducted a study at the Food Microbiology Laboratory, Institute of Food Science and Technology, BCSIR, Dhanmondi, Dhaka-1205 to determine the best sawdust substrate for mushroom growth. Mango, Jackfruit, Coconut, Jam, Kadom, Mahogony, Shiris sawdust with wheat bran and CaCO3 were used to test the development and yield of mushrooms on seven different substrates. Mango sawdust (150 g) produced the highest biological yield per packet, followed by Mahogony (148 g), Shiris (146 g), Kadom (136 g), Jam (114 g), Jackfruit (97 g), and Coconut sawdust (83 g). Coconut sawdust produced the lowest yield (83 g). However, Mango sawdust yielded the highest return (Tk 24.86), while Jackfruit sawdust yielded the lowest (Tk11.68). Following a cost-benefit study, Mango sawdust and Shiris sawdust were shown to be promising substrates for the growth of oyster mushrooms (*Pleurotus flabellatus*).

Dundar *et al*. (2008) determined the harvesting periods of three mushroom spices. They got the longest harvesting periods after three harvests were 85.27 days for *P. eryngii*, 82.64 days for P. ostreatus. The *P. sajor-caju* gave the highest yield as 20.2 g. *P. sajor-caju*, *P. ostreatus, and P. eryngii* had energy values of 229.22, 243.66, and 276.33 kcal/100 g dried matter, respectively. They found the maximum energy value was in *P. eryngii*,

Khan *et al*. (2008) determined the nutritional composition of six species of oyster mushrooms such as *Pleurotus sajor-caju*, *P. ostreatus*, *P. florida*, *P. cystidiosus*, *P. highking* 51 and *P. geestaranus*. They received that the protein content was highest in P. sajor-caju (24.5g/100g of dry weight) highest lipid content in *P. cystidiosus* (5.5g/100g dry sample) maximum carbohydrate content in *P. geestaranus* (45.9g/100g dry sample) maximum fiber content in *P. highking* 51 (30.3 g/100 g dry sample).

According to Mane *et al*. (2007) Pleurotus species are popular and highly grown throughout the globe, mostly in Asia and Europe, with simplicity and minimal production method, and increased biological efficiency.

As stated by Amin *et al*. (2007), mushroom growing has only been practiced in Bangladesh for a short time. Only a few mushroom species are now grown in this country, and among them *Pleurotus ostreatus*, *Pleurotus sajor-caju*, *Pleurotus florida*, and *Calocybe indica* are profound.

Namdev *et al*. (2006) investigated the effects of different straw substrates on oyster mushroom spawn growth and yield. In the case of gram straw, parthenium straw, sugarcane straw, and wheat straw, the number of days required for spawn run was much smaller (14 days), compared to 20 days for sunflower stalk, mustard straw, and paddy straw. Parthenium straw yielded very little (95 g/500 g dry substrates), whereas paddy straw yielded the most (666 g/500 g), followed by wheat straw and mustard straw (427 and 400 g/500 g, respectively).

Zape *et al*. (2006) investigated the spawn run, days taken to pinhead initiation, yield, and biological efficiency of three oyster mushroom species: *P. eurotnsJlonda*, *P. florida*, and *P. flahellatus*. They found *P. eurotnsJlonda* required a substantially shorter time for spawn run and pinning than *P. florida* and the yield was greater in *P. florida* than *P. flahellatus* and *P. eurotnsJlonda*.

Ostreatus planted on banana straw and rice straw, respectively, had 5.58 and 6.13 g of ash, according to Bonatti *et al*. (2004). In this study, the ash content of *P. ostreatus*, *P. eryngii*, and *P. sajor-caju* was determined to be 4.78, 4.89, and 5.84, respectively. *P. eryngii* has a moisture content of 7.23, *P. ostreatus* has a moisture content of 7.39, and *P. sajor-caju* has a moisture level of 7.42. The amino acid content of different mushroom species varies significantly (P 0.05). The content of each amino acid varies depending on the mushroom species. The mushrooms did not contain hydroxy-L-proline, and histidine was only discovered in *P. eryngii*. Aspartic acid provided the most amino acid in *P. eryngii* and *P. sajor-caju*, whereas methionine provided the least. Glutamic acid and methionine were the amino acids with the largest and lowest quantities in *P. ostreatus*, respectively.

To use straw as a substrate, the straw must first be chopped into reasonable sizes and then soaked in water for about 1-2 hours, and then it is rinsed 2 to 3 times in clean water and left for 3 to 4 hours before spawning can be done (Kwon and Kim, 2004). When evaluating lignocellulosic biomass from coconut palm as substrates for cultivation of *Pleurotus sajor-caju* (Fr.) Singer.

Moni *et al*. (2004) used paddy straw, banana leaves, sugarcane baggase, water hyacinth, and beetle nuthusk to grow oyster mushrooms (*Pleurotus sajor-caju*). The fruiting bodies were sun-dried and nutritional characteristics were measured. The composition of fruit bodies produced on various substrates showed significant heterogeneity. The percentage of moisture in the air ranged from 88.15 to 91.64 percent. Nitrogen and crude protein percentages ranged from 4.22 to 5.59 percent and 18.46 to 27.78 percent, respectively, on a dry matter basis, while carbohydrate percentages ranged from 40.54 to 47.68 percent. Crude fat and crude fiber composition varied from 1.49 to 1.90 percent and 11.72 to 14.49 percent, respectively.

Oh *et al*. (2004) experimented to improve the efficiency of the oyster mushroom substrate by using a composting methodology. Poplar sawdust and by-products of winter mushrooms, along with 10% rice bran, were composted outdoors for 12 days at 20°C to 28°C. The yield from the waste cotton substrate with fermented poplar sawdust was 742 g, compared to 663 g for the control. Furthermore, the substrate containing winter mushroom by-products was the most successful at composting. They concluded that using fermented sawdust and by-products in waste cotton for compost and oyster mushroom sporophore generation was beneficial.

Baysal *et al*. (2003) conducted an experiment to spawn running, pin head and fruit body formation and mushroom yield of oyster mushroom (*Pleurotus ostreatus*) on waste paper supplemented with peat, chicken manure and rice husk (90+10; 80 + 20 W:W). The fastest spawn running (mycelia development) (15.8 days), pin head formation (21.4 days) and fruit body formation (25.6days) and the highest yield (350.2 g) were realized with the substrate composed of 20% rice husk in weight. In general, increasing the ratio of rice husk withinthe substrate accelerated spawn running, pin head and fruit body formation and resulted increased mushroom yields, while more peat and chicken manure hada negative effect on growing.

According to Badshah *et al*. (1994), *Pleurotus ostrecilus* and *Pleurotus florida* were cultivated on wheat straw, sugarcane bagasse, corn cobs, or sawdust. They found *P. ostreatus* and *P. florida* yielded 49.8 and 277.7 g/2 kg substrate, respectively on sawdust and on wheat straw, 432.8 and 420.5 g/2 kg substrate, respectively while *P. ostreatus* and *P. florida*, yielded only 18.5 and 28.5 g/2 kg substrate, respectively on controls (growing in the field).

Pleurotus sajor-caju and *Pleurotus florida* were grown using water hyacinth alone and in conjunction with paddy straw (3:1, 1:1, and 1:3) by Pani and Mohanty (1998). The highest mushroom output was achieved using only paddy straw (83.3-84.6 percent BE). When combined with paddy straw, water hyacinth yielded larger yields than when used alone.

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out to find the best composting period and varieties for the highest yield of oyster mushrooms. This chapter includes a brief description of the experiment's location and design, treatments, substrate preparation, packet preparation, mushroom collection, and proximate analysis. The following headings and subheadings are applied to data collection and analysis:

3.1 Experimental site

The experiment was conducted in the laboratory and culture house of the Mushroom Development Institute, Savar, Dhaka from July 2019 to December 2019.

3.2 Experimental materials

Mother culture of mushroom was collected from Mushroom Development Institute (MDI), Savar, Dhaka, Bangladesh. Three selected species of oyster mushrooms such as, *Pleurotus djamor* (Pop*)*, *Pleurotus florida* (Flo*)*, and *Pleurotus ostreatus* (PO10) were cultivated in the culture house of the Mushroom Development Institute. The substrate used in the experiment was a mixture of different sawdust from mahogany tree (*Swietenia mahagoni*), mango tree (*Mangifera indica*) and rain tree (*Albiia saman*), collected from sawmill, Savar, Dhaka. The additive used for the cultivation of *Pleurotus* spp was wheat bran obtained from a feed mill, Savar, Dhaka.

Ethyl alcohol (70%) was used to rinse hands, to clean surfaces of the working area and to dip equipment. PH meter was used in measuring PH of the medium. Forceps, knife, tweezers, scalpels and petri plates were provided from scientific supply houses and were sterilized before use. Aluminum foil, brown paper, rubber band and cotton plug were used to prepare mother culture and spawn packet. Polythene sheet for covering the heap of the compost, water spray machine, trolly and rack were used for the cultivation of *Pleurotus djamor*, *Pleurotus florida*, and *Pleurotus ostreatus*.

3.3 Treatment

The experiment consisted of the following two treatment factors:

Factor A: Mushroom variety

V_1= *Pleurotus djamor* (Pop)

V_2 = *Pleurotus ostreatus* PO10

V_3= *Pleurotus florida* (Flo)

Factor B: Days of composted sawdust

T_0= 0 days

T_1= 5 days

T_2= 10 days

T_3= 15 days

T_4= 20 days

T_5= 25 days

T_6= 30 days

3.4 Experimental design

The experiment was laid out in Completely Randomized Design (CRD) with three replications. The experiments with twenty-one treatment combinations were conducted to achieve the desired objectives.

3.5 Preparation of pure culture

Pure cultures of three species were prepared on Potato Dextrose Agar (PDA) medium. A fresh and juvenile stage sporophore of the above-mentioned mushrooms were collected and surface sterilized with 70% alcohol by rubbing cotton soaked in alcohol. Tissues were collected from inner region of the joint of stalk and pileus. The tissues were cut into small pieces and placed on the solidified test tube which contained PDA. After inoculation, the tube was covered with cork. All operations were done under sterile condition in a clean bench. The inoculated tubes were kept in a growth chamber maintaining temperature at 20-25^{0}C and incubated 8-15 days until the tubes full of whitish mycelia. Then the pure culture was used for inoculation of mother culture.

3.5.1 Component and preparation of PDA media

The following necessary components were blended for one (1) liter of PDA medium.

Name	Amount
Potato	250 g
Dextrose	20 g
Agar	20 g
Aspersing	250 mg
Tetracycline	250 mg

Procedure for PDA media preparation: 250g potatoes were measured using an electronic balance for one (1) litter of PDA Media. The potato pills were then cut into small pieces with a knife. The little potato pieces were cooked for 45 minutes with one litter water and then filtered through a fine cloth. The remaining 1L water was mixed with all of the chemical components of the PDA media. The combined solution was then simmered for 15 minutes and occasionally stirred with a stick. 10 mL of the solution was placed into each contamination-free petri plate after it had been boiled.

3.6 Preparation of mother culture

To prepare mother culture of test mushroom sawdust and wheat bran mixed together at the ratio of 2:1 (v/v). Water was added to adjust moisture content at 65% and $CaCO_3$ was mixed at the rate of 0.2% of the mixture. Polypropylene bags of 18 cm × 25 cm size were filled with 300g of the above-prepared mixture and packed tightly. The neck of the bag was prepared by using heat resistant plastic pipe. A hole of about 2/3 deep of the volume of the bag was made for space to put the inoculums. The neck was plugged with cotton and covered with brown paper and tied with a rubber band. The packets were sterilized in an autoclave for one (1) hour at 121^0C under 1.5 kg/cm^2 pressure. After sterilization, the packets were cooled for 24 hours and transferred into a clean bench. A piece of pure PDA culture medium containing mycelium of test oyster mushroom was placed aseptically in the hole of mother culture packet and again plugged the packet as mentioned above. The inoculated packets were placed on a rack in the laboratory at 22 ± 2^0C temperatures for incubation. The substrate of the mother culture was colonized by the growth of whitish mycelium within 15-20 days after inoculation. The fully colonized packets were used for spawning.

3.7 Sawdust composting for mushroom cultivation

The sawdust was clean and air-dried. Water was added to them until the moisture level of about 70% was reached, using the thumb test. The mixture was stacked to make a heap of 1m x1m x 1m (length, breadth and height) on the floor. The sawdust was composted in six groups with composting times of 5, 10, 15, 20, 25 and 30 days. Temperatures and pH measurements were taken three times in a day morning, afternoon, evening at the middle, and bottom of the compost heap. Turning, a process of disassembling and reassembling of compost was also done during intervals to allow compost aeration, full mixing of the composting and thereby prevent uneven decomposition. The compost according to the treatments was used in the preparation of the different substrate formulations.

3.8 Preparation of spawn packets

The substrate of spawn packets was prepared using composted sawdust and wheat bran mixture at the ratio of 2:1. Water was added to make the moisture level about 65% and $CaCO_3$ was added at 0.2% (w/w) of the mixture. The substrate mixture was poured into 18 cm × 25 cm polypropylene bags at 500g/bag. The neck of the bag was prepared by using heat resistant plastic pipe. A hole of about 2/3 deep of the bag was made for space to introduce the inocula. The neck of each poly bags was plugged with cotton, covered with brown paper and tied with a rubber band. The packets were sterilized in an autoclave for 2 h at 121^0C under 1.1 kg/cm^2 pressures. After sterilization, the packets were cooled and transferred to an inoculation chamber. The packets were inoculated separately with the mother culture of the three varieties at the rate of one teaspoonful per packet. The inoculated packets were incubated at 22 ± 2^0C.

3.9 Incubation

The process of mycelium germination and substrate colonization is known as incubation. Further fruiting and the predicted fruiting output are dependent on the proper incubation conditions. The bags were stacked on the incubation room's wooden shelves. Aeration was achieved by leaving 10 cm between treatments. The development of white threads through the substrates was used to track the formation of mycelia regularly. Following that, the mushroom cultures were transported to the fruiting chamber for basidiocarp production. Polyethylene bags were removed, and the cultures were incubated at 22 ^{0}C for 12 hours per day under the light of cool white fluorescent bulbs. During the incubation period for basidiocarp production, electric fans were employed for 4 hours per day to maintain a uniform ventilation environment in the incubation room.

3.10 Opening the spawn packets

The rubber band, cotton plug, and plastic neck of the mouth of the spawn package were removed once the mycelium running was completed, and the mouth was tightly wrapped with a rubber band. Then two ends, opposite to each other of the upper position i.e. on shoulder of plastic bag were cut in "D" shaped with a blade and opened by removing the plastic sheet after which the opened surface of substrate was scraped slightly with a blade for removing the thin whitish mycelial layer.

3.11 Culture conditions for fruiting

During the cropping phase, the bags were sprayed with tap water 5-6 times a day to keep them moist. The relative humidity was 70-85% and the temperature was maximum 27°C and minimum 22°C. The relative humidity (RH %) and the temperature were maintained by watering daily. Mushroom fruiting bodies were picked around a week following pinhead formation when the gills were fully formed and the caps' edges were still curled under.

3.12 Data collection

Data were collected on the following parameters:

3.12.1 Mycelium growth rate (MGR) (cm/day)

Mycelium growth rate was measured after the mycelium colony cross the shoulder of the packet.

3.12.2 Time required to completion of mycelium running (days)

Complete mycelium running was recorded from date of inoculation to date of spawn packet opening.

3.14.3 Time required for primordial initiation (days)

Time from stimulation to primordial initiation (days) was recorded.

3.14.4 Time required from pinhead initiation to 1st harvest (days)

Days required from pinhead initiation to 1st harvest were recorded.

3.14.5 Number of fruiting body

The number of the total fruiting body was recorded.

3.14.6 Number of effective fruiting body

The number of the well-developed fruiting body was recorded. A dry and pinheaded fruiting body was discarded but a twisted and tiny fruiting body was included during counting.

3.14.7 Thickness of pileus (cm)

The thickness of the pileus of four randomly selected fruiting bodies was recorded by using a slide caliper.

3.14.8 Diameter of pileus (cm)

The diameter of the pileus of four randomly selected fruiting bodies was recorded by using a slide caliper.

3.14.9 Length of stipe (cm)

The length of stipe of four randomly selected fruiting bodies was recorded by using slide calipers.

3.14.10 Diameter of stipe (cm)

The stipe diameter of four randomly selected fruiting bodies was recorded by using a slide caliper.

3.14.11 Biological Yield (g)

The biological yield g/500 g packet was recorded by weighing the whole cluster of fruiting body without removing the lower hard and dirty portion.

3.14.11 Biological Efficiency (%)

The biological Efficiency was calculated by using the following formula:

$$\text{Biological efficiency (\%)} = \frac{\text{Biological yield (g)}}{\text{Total dried substrate used (g)}} \times 100$$

3.15 Statistical analysis

The experiment was laid out following a completely randomized design (CRD) with 3 varieties, seven composting periods and 3 replications and each replication contained twenty-one populations. Data were analyzed following Gomez and Gomez (1984) using the MSTAT-C computer program and Excel software. Mean separation was computed following Least Significant Difference (LSD) using the same computer program.

CHAPTER IV

RESULTS AND DISCUSSION

An experiment was conducted to find out the suitable combination of sawdust composting period with varieties for quality production of oyster mushroom. Results of the present study have been presented and discussed in this chapter under the following headings.

4.1 Mycelium growth rate (MGR) (cm/day)

The mycelium growth rate ranged from 0.45 to 0.54 cm of different oyster mushrooms varied significantly in this study (Table 1). The V_2 (0.54 cm) had the highest mycelium growth rate, which is statistically similar to V_1 (0.53 cm), while V_3 had the lowest mycelium growth rate (0.45 cm).

A significant variation was recorded in the mycelium growth rate among the different treatments due to the effect of days of composted sawdust (Figure 1). The maximum mycelium growth rate was found in T_3 (0.67 cm) whereas the minimum mycelium growth rate was found in T_1 (0.45 cm) which is statistically similar to all other treatments. The substrate, sawdust, had the lowest mycelium growth rate, possibly due to the presence of various polyphenolic compounds in them, as suggested by Wang (1982), as well as low cellulose content by Gohl (1993).

The mycelium growth rate was statistically influenced by the combined effect of oyster mushroom varieties and days of composted sawdust (Table 2). The growth rate of mycelium was ranged from 0.68 cm to 0.27 cm. The highest mycelium growth rate was recorded in treatment combination of V_1T_3 (0.68 cm) which is statistically identical to V_2T_3 (0.67 cm) and V_3T_3 (0.66 cm). The lowest mycelium growth rate was recorded in V_3T_0 (0.27 cm). Different composted sawdust showed different mycelium running because of different carbohydrate based on availability and the environment of the spawn. Mondal *et al*. (2010) found that the mycelium running rate in spawn packet ranged from 0.50 to 0.79 cm/day.

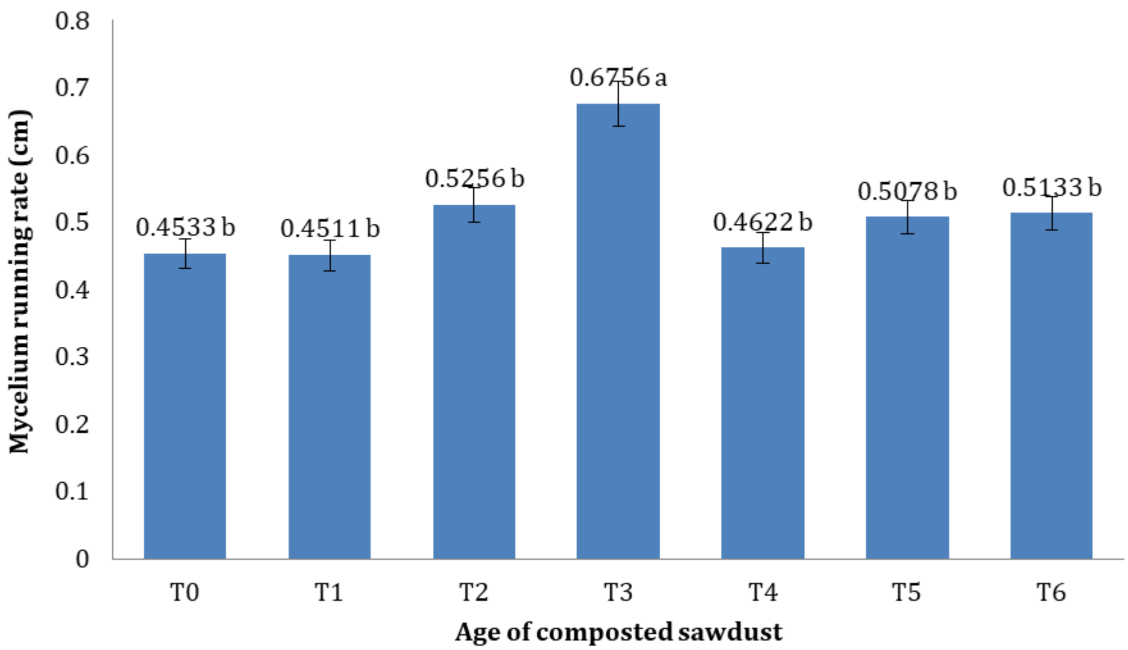

Figure 1: **Effect of days of composted sawdust on the mycelium running rate. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)**

4.2 Time required to completion of mycelium running (days)

The influence of various species of oyster mushrooms caused a significant difference in completion of mycelium running, which ranged from 21.29 to 22.00 (Table 1). The highest days required for completion of mycelium running was (22.00 days) obtained from V_3 *(Pleurotus florida)* which was statistically similar (21.71 days) to V_2 (*Pleurotus ostreatus)*. The lowest days required for completing mycelium running was (21.29) days obtained from V_1 *(Pleurotus djmor)*. The results on mycelial running were more or less similar to the findings of Shah *et al*. (2004). He reported that the spawn running took about 16-25 days after inoculation. Vetayasuporn (2007) reported that *Pleurotus ostreatus* completed spawn running in 17-20 days on different substrates and the time for pinhead formation was between 6 to 7 days. Also, Bhatti (1987) suggested that the variation completing mycclium running of oyster mushroom on different substrates may be due to their different compositions.

Because of the influence of days of composted sawdust, there were substantial variations in days required for completion of mycclium running (Figure 2). The maximum days required for completion of mycclium running was found in T_6 (23.00 days) which is statistically similar to T_4

(22.44 days). The minimum days required for completing mycelium running were found in T_3 (20.56 days) which is statistically alike to T_2 (20.78 days), T_0 (21.33 days) and T_1 (21.56 days). The appreciable days to complete mycelium running of oyster mushroom on different substrates might be due to variations in their chemical composition and C: N ratio as reported by Okhuoya *et al*. (2005).

The combined impact of different mushroom varieties and days of composted sawdust showed a notable variation on completion of mycclium running (Table 2). The treatment combination of V_2T_4 and V_3T_6 took the maximum time (23.67 days) required to complete mycelium running, whereas, the treatment combinations of V_1T_2 took the lowest number of days (19.00 days) to complete mycelium running. This variation could, in turn, be attributed to the variations in chemical composition and Carbon to Nitrogen ratio (C: N) of the substrates used Bhatti *et al*. (1987). This result was also in agreement with Shah *et al*. (2004) who reported that the mycelium running took 16.67- 25.00 days after inoculation in case of *Pleurotus ostreatus*.

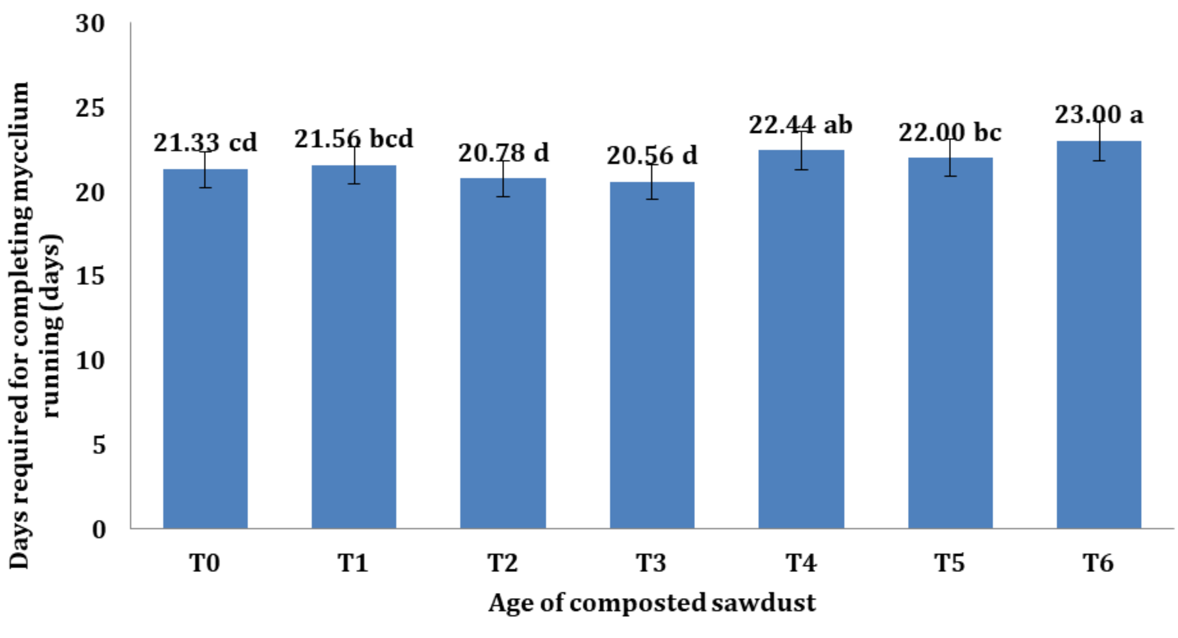

Figure 2: Effect of days of composted sawdust on the time required to completion of mycclium running. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.3 Time required for primordial initiation (days)

Time required for primordial initiation had a wide range of effects, ranging from 7.57 (days) to 7.14 (days) (Table 1). The highest time needed for primordial initiation was obtained in V_3 (7.57 days), which is statistically similar to V_2 (7.33 days), and the lowest time was reported in V_1 (7.14 days). According to Moonmoon *et al*. (2010) variations in the results were due to the genetic makeup of different kinds of species.

Due to the impact of days of composted sawdust, time required for primordial initiation showed a noticeable difference. Figure 3 indicated that T_0 (7.88 days) had the maximum value, which was statistically similar to T_1 (7.77 days). The minimum time requirement for primordial initiation was found (6.66 days) in T_3 (Figure 3).

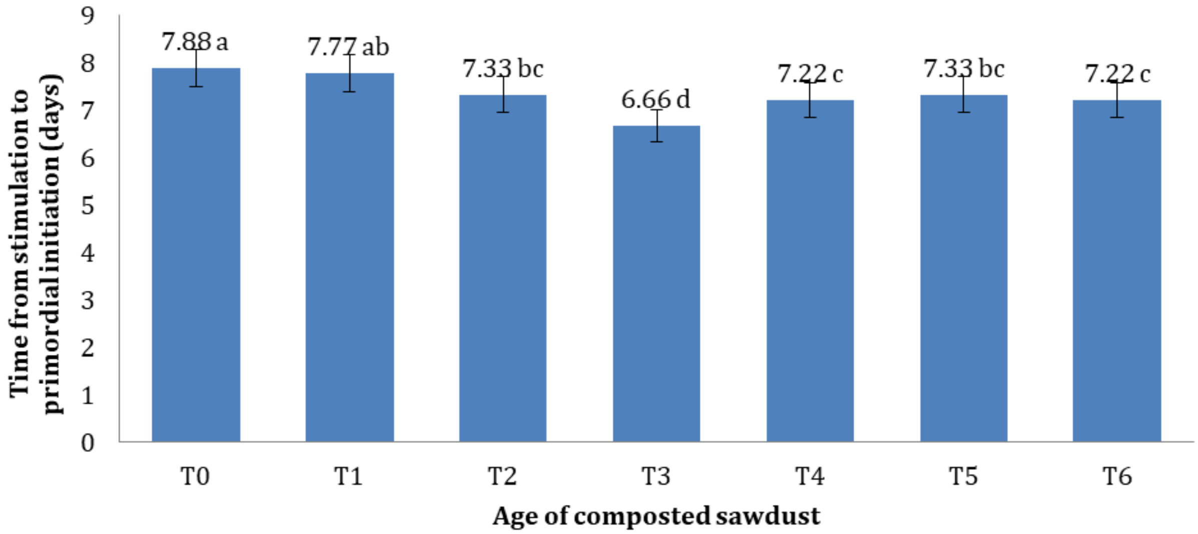

Figure 3: Effect of days of composted sawdust on the time required for primordial initiation. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

Table 2 showed the time required for primordial initiation varied significantly due to the cumulative influence of varieties and days of composted sawdust, ranging from 8.33 days to 5.66 days. Treatment combination of V_3T_0 (8.33 days) required the highest time for primordial initiation, which was statistically similar to most of the studied treatment combinations. The lowest time for primordial initiation (5.66 days) was found in V_2T_3.

4.4 Time required from pinhead initiation to 1st harvest (days)

Different mushroom varieties had a significant impact on the days required from pinhead initiation to the first harvest in this study. According to Table 1, the maximum days required from pinhead initiation to first harvest (4.85 days) in V_3. The least number of days from pinhead initiation to the first harvest (4.52 days) was discovered in $V_{1,}$ which is statistically similar to V_2 (4.66 days).

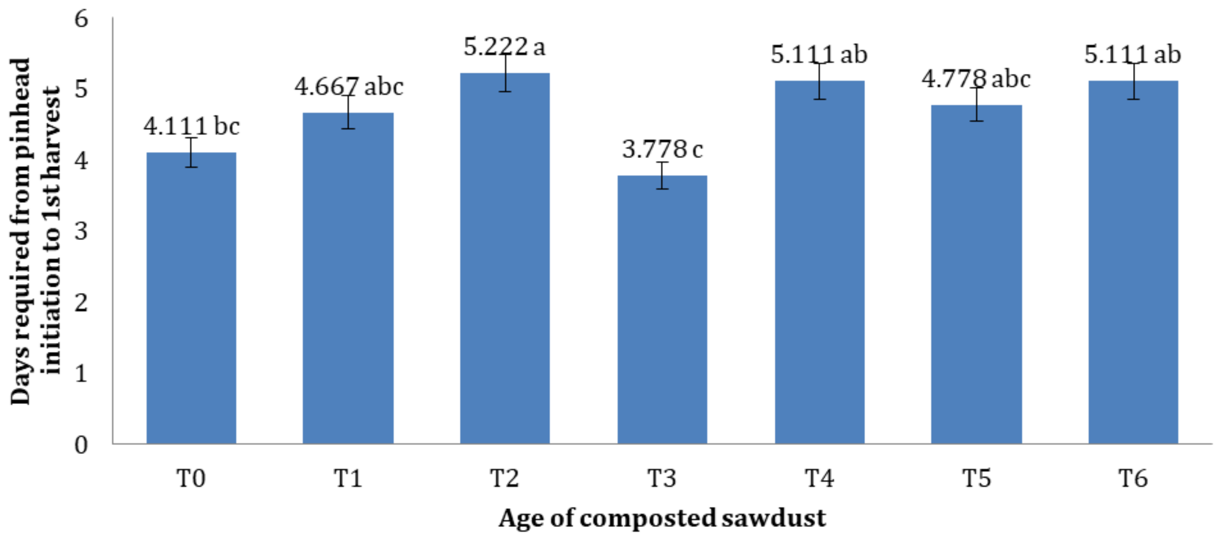

Figure 4: Effect of days of composted sawdust on the time required from pinhead initiation to 1st harvest. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

The days required from pinhead initiation to first harvest indicated a significant difference due to the influence of composted sawdust days (Figure 4). The same number of days is required from pinhead initiation to first harvest in T_2 (5.22 days) as well as T_4, T_6, T_5, and T_1. Lowest value was observed in T_3 (3.77 days).

Days required from pinhead initiation to first harvest exhibited less variance due to the combined effect of mushroom varieties and days of composted sawdust. In Table 2, the maximum days from pinhead initiation to first harvest (5.67 days) were required in V_2T_1, which was statistically similar to the majority of the other treatment combinations. On the other hand, the V_2T_3 showed the shortest time between pinheads initiation to first harvests (3.33 days), which was statistically comparable to the others. For the growth and penetration of the mycelium into basal substrates which ultimately influences fruiting bodies of mushrooms, the structure and porosity levels (oxygen availability) of substrate are important factors to be considered by Philippoussis *et al*. (2002).

4.5 Number of Fruiting Body

The number of the total fruiting body significantly differed among the different varieties of oyster mushroom (Table 1). The highest number of total fruiting body was found in V_2 (13.97) which are statistically similar to V_1 (13.46) and the lowest number of the total fruiting body was found in V_3 (4.36).

The result of the present findings keeps in with the findings of Sarker *et al*. (2007). They reported that *Pleurotus ostreatus* performed best among the different mushroom varieties to produce maximum number of fruiting bodies. Also, Luky, 2015 stated that the highest number of fruiting body (16.53) was observed in *Pleurotus ostreatus*. A significant variation was recorded in the number of total fruiting bodies among the different treatments due to the effect of days of composted sawdust (Figure 5). The maximum number of total fruiting bodies was found in T_3 (11.57), which are statistically similar to the majority of other treatments T_1 (11.05), T0 (10.88) T_5 (10.67) and T_6 (10.56). The minimum number of the total fruiting body was found in T_2 (9.17) which were not statistically similar to others. Sarker *et al*. (2007) found similar results. He stated that total carbon (C), total nitrogen (N), Carbon/Nitrogen ratio (C/N) is important factors that determine the mycelium colonization and development of fruiting bodies in oyster mushroom.

The number of the total fruiting body was influenced by the combined effect of oyster mushroom varieties and days of composted sawdust (Table 2). The highest number of the total fruiting body was recorded in treatment combination of V_1T_3 (15.26). The lowest number of the total fruiting body was recorded in V_3T_4 (3.26).

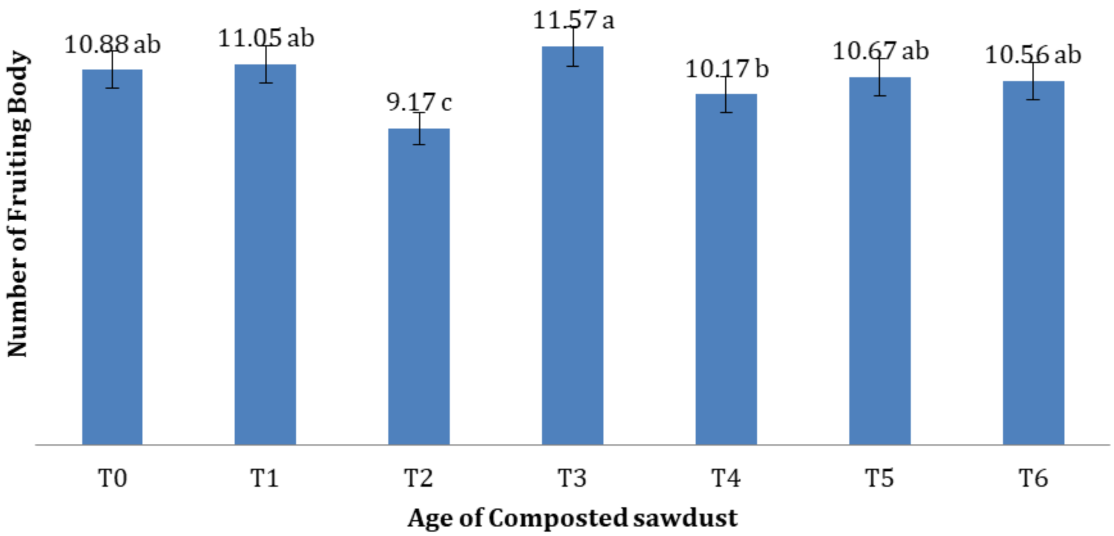

Figure 5: Effect of days of composted sawdust on the number of fruiting body. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.6 Number of Effective Fruiting Body

Statistically significant variation of the number of the effective fruiting body of different varieties of oyster mushroom was observed in Table 1. The largest number of effective fruiting body was found in V_2 (11.43) which were statistically similar to V_1 (10.92). The lowest number of the effective fruiting body was found in V_3 (2.54).

The effect of days of composted sawdust in the number of the effective fruiting body showed significant variation (Figure 6). The topmost number of the effective fruiting body was found in T_3 (9.21) which was statistically identical to T_4 (8.84) and comparable to the majority of other treatments. The lowest number of the effective fruiting body (6.72) was found in T_2. This variation in number of the effective fruiting body in different aged compost could be due to the variations in chemical composition and carbon-nitrogen ratio (C: N) of the compost used (Bhatti *et al*. 2007).

With the combined effect of mushroom varieties and days of composted sawdust, the number of the effective fruiting body significantly differed. It was in the range of 12.46 to 1.73 (Table 2). The largest number of effective fruiting bodies (12.46) was found in V_2T_3, while the poorest number of effective fruiting bodies (1.73) was found in V_3T_5. Dada and Fasidi (2018) also found similar results and showed that long composted sawdust had the highest mean number of healthy fruit bodies than those of the short composted substrate and non-composted (control) substrate.

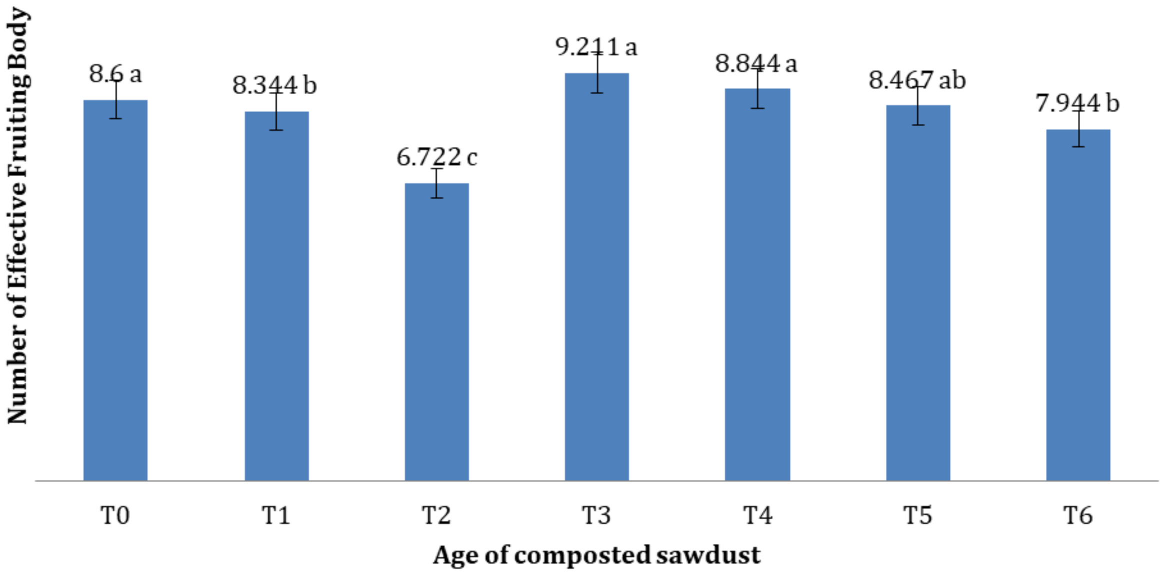

Figure 6: Effect of days of composted sawdust on the number of effective fruiting body. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.7 Thickness of Pileus (cm)

The influence of various species of oyster mushrooms caused a non-significant difference in pileus thickness, which ranged from 0.70cm to 0.62cm (Table 3). The highest thickness was found in V_2 (0.70 cm) which was statistically similar to V_1 (0.64 cm) and the lowest thickness of pileus (0.62 cm) was found in V_3.

There were not significant variations in pileus thickness because of the influence of days of composted sawdust (Figure 7). The highest pileus thickness was found in T_5 (0.73cm). The lowest pileus thickness was found in T_2 (0.62 cm) and T_6 (0.62). Ponmurugan *et al*. (2007) agreed to current results and stated that higher yield of mushroom in 25 days aged compost is due to easier nutrient solubilization in cellulosic substances, once they start to degrade (Ponmurugan *et al*. 2007).

The thickness of pileus was not significant depending on the combined action of different oyster mushrooms varieties and days of composted sawdust (Table 4). In V_2T_3, the pileus was found to be the thickest (0.81cm) which is statistically similar to some other treatment combinations. In V_3T_3, (0.40cm) the pileus was found to be the thinnest. Here *Pleurotus ostreatus* and 15 days old composted sawdust gave best result. Pileus thickness may be higher due to the presence of adequate nutrient in the substrates. As it is a yield attributing character so the higher thickness of pileus may increase the yield.

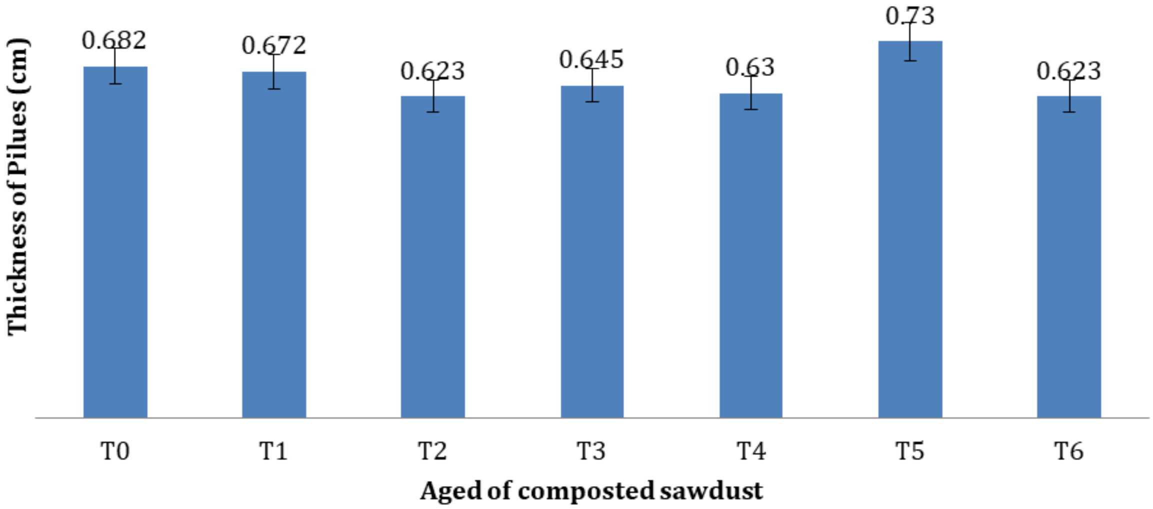

Figure 7: Effect of days of composted sawdust on thickness of pileus. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.8 Diameter of Pileus (cm)

The effect of various species of oyster mushroom on pileus diameter varied considerably, ranging from 10.79cm to 6.47cm. Table 3 showed that the pileus with the largest dimension was discovered in V_3 (10.79cm). Treatment V_2 (6.47cm) has the smallest pileus diameter, which was statistically similar to V_1 (6.65cm). The variations in the results, according to Moonmoon *et al*. (2010) different genetic makeup of different varieties give varied result.

Attributed to the influence of days of composted sawdust, the diameter of the pileus demonstrated a significant variation. The pileus with the largest diameter was discovered in T_2

(10.98cm). T_4 (6.07cm) had the smallest pileus diameter, which was statistically similar to T_5 (6.09cm) treatment (Figure 8). Samuel and Eugene (2012) observed that pileus diameter ranged from 1.91 to 5.69 cm on different substrates. Among the most used cultivation supplements, composts are sources of organic nitrogen (N_2), necessary to the growth of the mycelium mass, which may interfere in productiveness and biological efficiency of the fungus (Bellettini *et al*. 2019).

The diameter of pileus varied significantly due to the cumulative influence of varieties and days of composted sawdust, with diameters ranging from 13.53cm to 5.11cm (Table 4). V_3T_2 (13.53cm) had the largest pileus diameter, which was statistically similar to V_3T_6 (13.27cm). The pileus with the smallest (5.11cm) diameter was found in V_1T_6. Use of compost can increase soil organic matter and water holding capacity and provide slow releasing nutrients to crops, which can lead to long-term yield increases (Hitchings 2008).

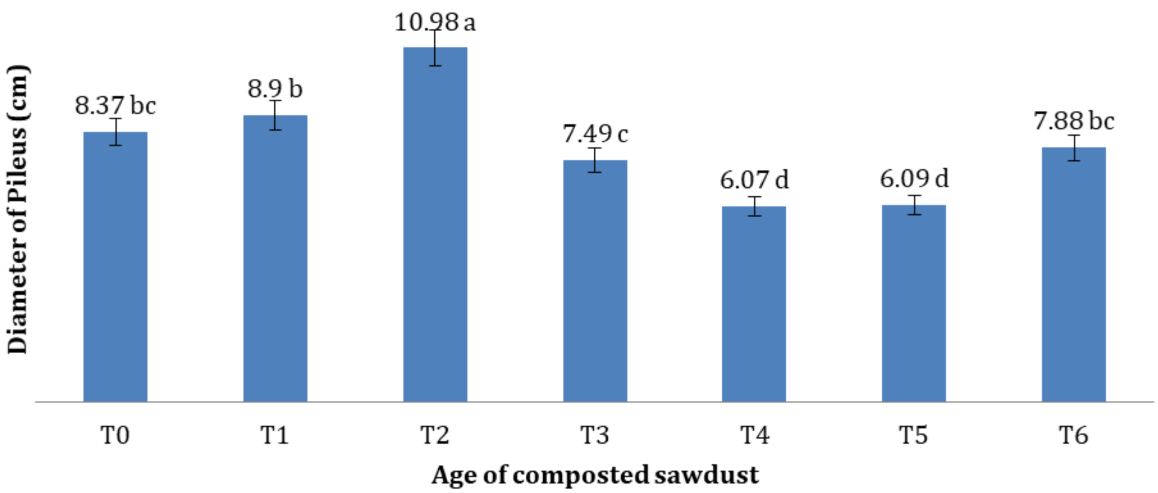

Figure 8: Effect of days of composted sawdust on diameter of Pileus. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.9 Length of Stipe (cm)

The length of the stipe was greatly diverged by the influence of different varieties, ranging from 4.60cm to 2.06cm shown in Table 3. The longest stipe was found in V_3 (4.60cm), while the shortest stipe was in V_1 (2.06cm).

Length of the stipe showed a noticeable difference due to the effect of days of composted sawdust (Figure 9). T_3 (3.24cm) had the longest range, which was statistically comparable to T_2 (3.20cm). The stipe length was found to be the shortest (2.17 cm) in T_4.

Significant variation in stipe length was observed due to the combined influence of varieties and days of composted sawdust (Table 4). The stipe length varied from 5.43 cm to 1.69 cm. The longest stipe length was found in V_3T_3 (5.43cm), while the shortest stipe (1.69cm) length was found in V_1T_2. On the other hand, length of stipe took a different pattern where the mixed substrates composted for 7 and 14 days gave mushrooms with higher stipe length of 4.3 cm and 4.8 cm respectively while the sole coir substrates composted for one day produced mushrooms with longer stipe length of 5.2 cm and 2.7 cm respectively during the two trials. Ajonina and Tatah (2012) stated that physical quality of oyster mushroom depends on the length of stipe. Mondal *et al*. (2010) noted that the higher the stipe length, the poorer the quality of the mushrooms.

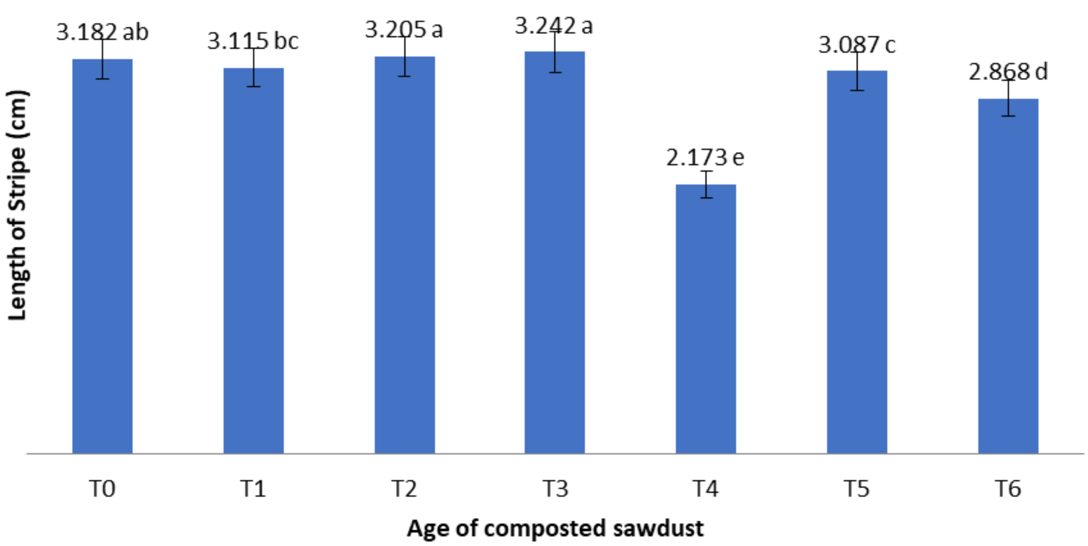

Figure 9: Effect of days of composted sawdust on length of stripe. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.10 Diameter of the Stipe (cm)

A significant variation in the diameter of stalk was found among the varieties. Table 3 showed that the highest stipe diameter was recorded at V_3 (1.57 cm) and the lowest was obtained from V_2 (1.11 cm) which was statistically similar to V_1 (1.18cm). Lucky (2015) reported that The stipe diameter ranged from 0.72 to 1.14 cm in different oyster mushroom species.

Owing to the influence of days of composted sawdust, there was a great disparity in the diameter of the stipe, which varies greatly from 1.60 cm to 0.99 cm (figure 10). T_3 (1.60 cm) had the largest stipe diameter, which was statistically similar to T_0 (1.59 cm). T_2 has the stipe with the smallest (0.99 cm) diameter. Oyetayo and Ariyo (2013) stated that mushrooms cultivation influenced by the nature of the substrates employed. The quantity and the kind of compost may vary according to the species or the strain under development as well as the growth stage (Donini *et al*. 2009).

The diameter of the stipe varied significantly depending on the combined influence of various oyster mushroom types and days of composted sawdust. The stipe with the largest diameter was found in V_3T_3 (2.35cm) and the smallest stipe's (0.61 cm) diameter was found in V_2T_2 (Table 4). Similar results were found by Mondal *et al*. (2010). The mixed substrates produced mushrooms with the highest stipe width and cap perimeter among the three substrates studied.

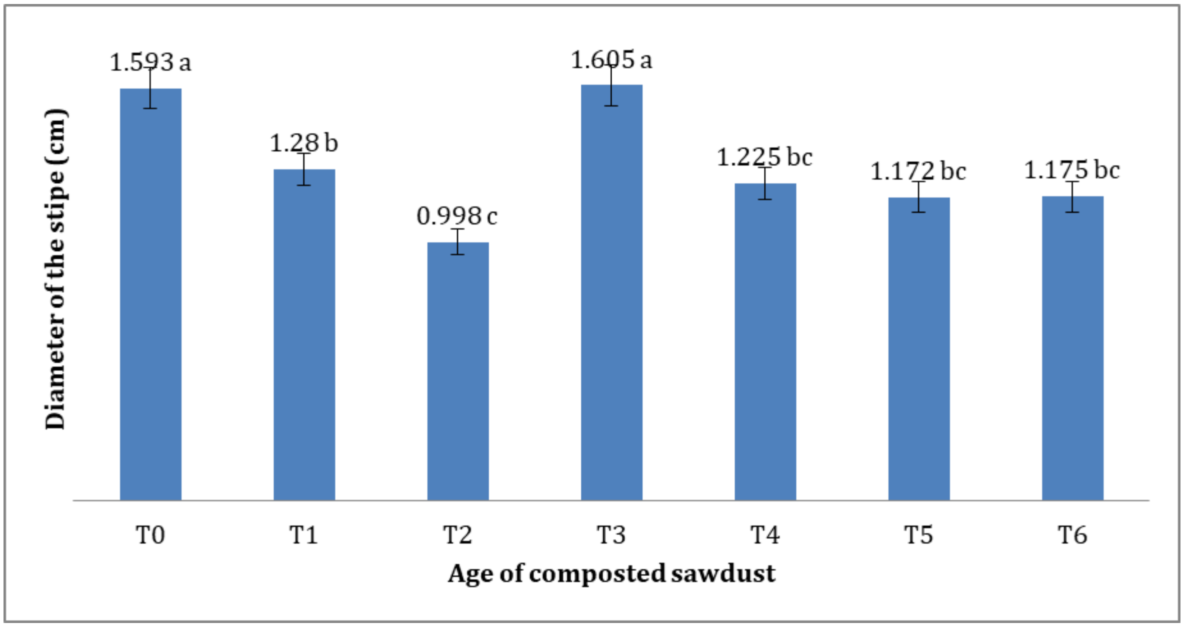

Figure 10: Effect of days of composted sawdust on diameter of stipe. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.11 Biological Yield (g)

In this investigation, in terms of biological yield, various mushroom varieties showed considerable variation (Table 3). The maximum biological yield of mushroom (50.12 g) was obtained from V_2 treatment, and the minimum yield (48.57 g) was obtained from V_3 treatment which was statistically comparable to V_1 (49.01 g).

Because of the impact of days of composted sawdust, there was a significant variation in biological yield (Figure 11). T_3 (55.00 g) had the highest biological yield, which was substantially different from the other therapies, followed by T_0 (51.789g), T_5 (51.30 g), T_4 (49.39 g) and T_6 (49.14 g) treatments. T_2 produced the least biological yield (42.43 g). The mycelia of this oyster mushroom have different colonizing potentials for the substrates in which they are grown, which ultimately corresponded to the yield obtained. The highest yield 15 days compost appeared to be due to comparatively better availability of nitrogen, carbon and minerals from this substrate (Shah *et al*. 2004). Mycelia of *Pleurotus* species are well known to colonize various lignocellulosic materials due to their extensive enzyme systems capable of utilizing complex organic compounds, which occurs in organic matter residues (Tisdale *et al*. 2006 and Mane *et al*. 2007).

The interaction between various mushroom varieties and days of composted sawdust showed a notable variation on biological yield (Table 4). The maximum yield (56.50 g) was produced by V_2T_3 which was statistically close to V_1T_3 (55.06 g) and the minimum yield (38.13g) was produced by V_3T_2.

In this research *P. Ostreatus* variety with 15 days aged sawdust compost performed best among the different treatment combination. The variety has a great impact on crop production because their different genetic constituents. Particularly, *P. ostreatus* requires a shorter growth time, convert a high percentage of the substrate to fruiting bodies, less prone to pest and diseases and give higher yield in a suitable environment in comparison to other edible mushrooms (Sanchez 2009). On the other hand, different composting materials with different ages also have a vast influence on crop growth and development. Because composted sawdust is rich in moisture, lignin, cellulose, and crude protein, with favorable temperature which are utilized by the mushroom mycelium as a source of nutrition. Between the cellulose content of the substrate and enzyme production of the mushrooms has a positive relationship in determining the yield of a mushroom crop. This relationship led to better uptake of nutrients for sporophore formation leading to higher fresh weights and enhanced performance of mycelia due to availability of several amino acids, protease as well as transaminase enzyme activities (Shashirekha *et al*. 2005). Besides this the Carbon: Nitrogen ratio of the compost substrate plays an important role in mushroom production. With the advancement of time, the compost releases more carbon and nitrogen that is needed for the crop growth and development. At the same time, the role of added supplements was found to be high yield (Onyango 2011).

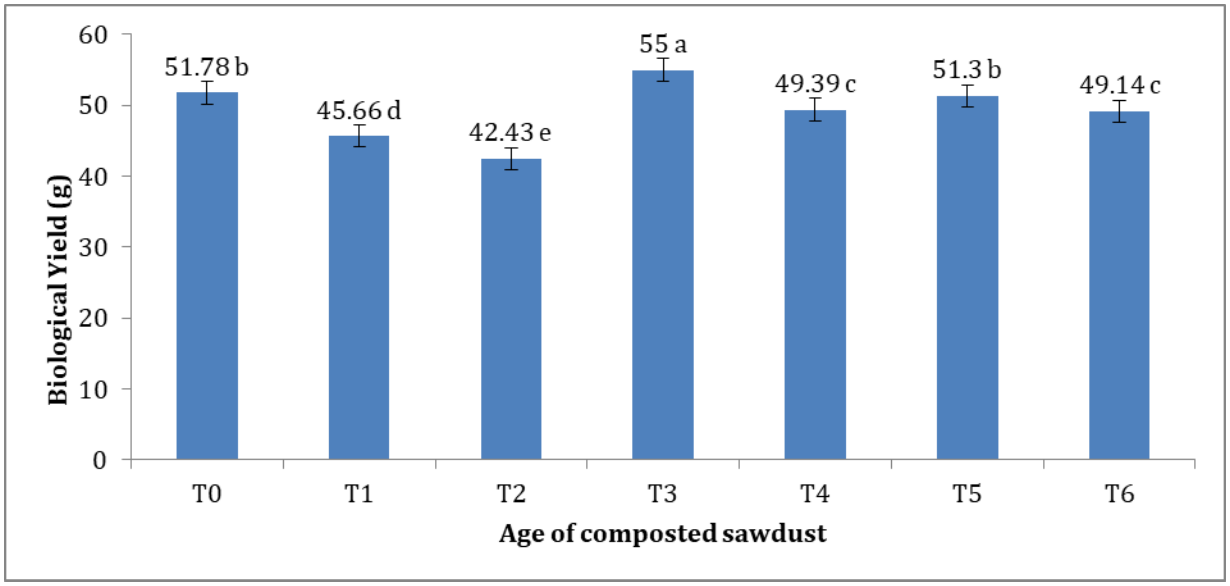

Figure 11: Effect of days of composted sawdust on biological yield. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

4.12 Biological efficiency (%)

Biological efficiency varied significantly due to effect of different varieties of oyster mushroom (Table 3). The maximum biological efficiency (28.64%) was obtained from V_2 and the minimum biological yield (27.75%) was obtained from V_3.

Biological efficiency significantly differed on days of composted sawdust (Figure 12). T_3 produced highest biological efficiency (31.42%). The lowest biological efficiency (24.24 %) was obtained from T_2 which differ from rest of the treatments.

Biological efficiency was significantly influenced by the combined effect of different varieties of oyster mushroom and composting period which ranged from 32.28% to 21.78% (Table 4). The highest biological efficiency (32.28 %) was found in V_2T_3 which was statistically similar to V_1T_3 (31.74%). The lowest efficiency was found in V_3T_2 (21.78%).

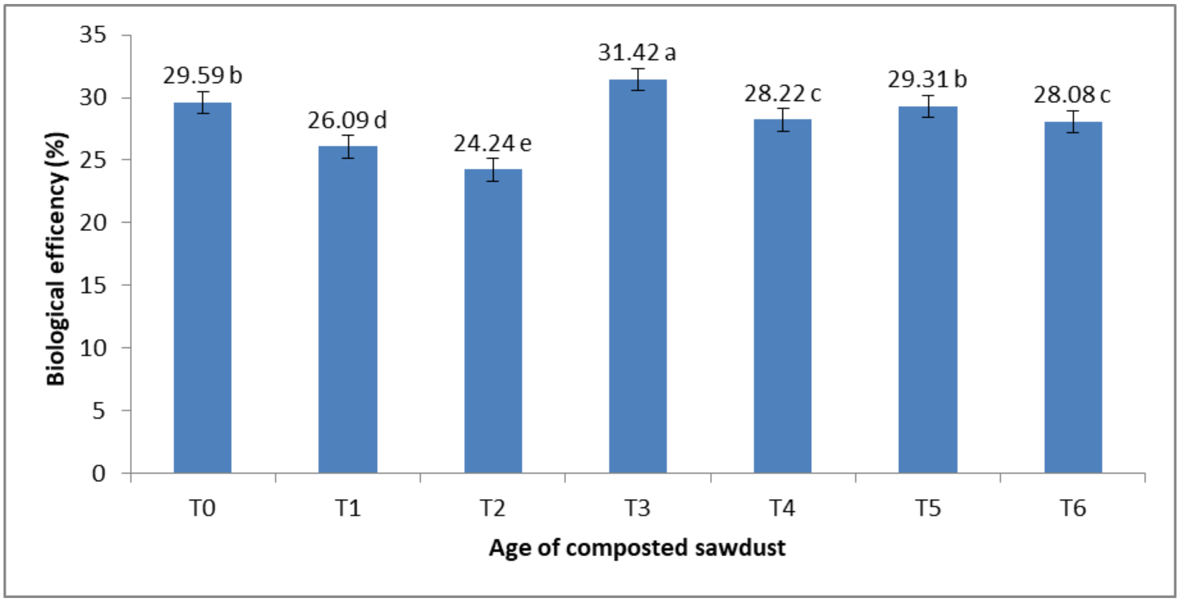

Figure 12: Effect of days of composted sawdust on biological efficiency. T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

Table 1. Effect of variety on growth parameters (the mycelium growth rate, time required to completion of mycelium running and time required for primordial initiation), and yield related parameters (number of fruiting body and number of effective fruiting body) of oyster mushroom

Variety	Mycelium growth rate (cm/day)	Time required to completion of mycelium running (days)	Time required for primordial initiation (days)	Time required from pinhead initiation to 1st harvest (days)	Number of fruiting body	Number of effective fruiting body
V_1	0.53a	21.29b	7.14b	4.52bc	13.46a	10.92a
V_2	0.54a	21.71ab	7.33ab	4.66bc	13.97a	11.43a
V_3	0.45b	22.00a	7.57a	4.85a	4.36b	2.54b
LSD (0.05)	0.01	0.6218	0.32	0.52	0.62	0.55
CV (%)	6.16	4.65	7.27	9.32	9.48	10.28

In a column, means followed by a common letter are not significantly differed of 5% level by DMRT.
Variety: V_1 (*P. djmor*), V_2 (*P. ostreatus*), V_3 (*P. florida*)

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Table 2. Combined effect of varieties and composting period of sawdust on growth related parameters (the mycelium growth rate, time required to completion of mycelium running and time required for primordial initiation), and yield related parameters (number of fruiting body and number of effective fruiting body) of oyster mushroom

Treatments	Mycelium growth rate (cm/day)	Time required to completion of mycelium running (days)	Time required for primordial initiation (days)	Time required from pinhead initiation/opening to 1st harvest (days)	Number of fruiting body	Number of effective fruiting body
V_1T_0	0.54bc	21.67bcde	7.66abc	4.00cd	14.13a	11.56a
V_1T_1	0.49bcd	21.67bcde	7.00bc	3.33d	14.16a	11.33a
V_1T_2	0.50bcd	19.00g	7.33 abc	5.33ab	8.66b	6.40b
V_1T_3	0.68a	19.67fg	6.00de	4.00cd	15.26a	12.23a
V_1T_4	0.42efg	22.33abcd	7.33abc	4.66bc	13.96a	12.067a
V_1T_5	0.52bc	22.67abc	7.66abc	5.00ab	14.43a	12.06a
V_1T_6	0.53bc	22.00abcd	7.00bc	5.33ab	13.63a	10.83a
V_2T_0	0.52bc	20.00efg	7.66abc	3.33d	13.83a	11.40a
V_2T_1	0.48cd	22.00abcd	8.00ab	5.67a	13.90a	10.86a
V_2T_2	0.52bc	22.67abc	7.33abc	5.33ab	13.96a	10.93
V_2T_3	0.67a	19.67fg	5.66e	3.33d	14.83a	12.46a
V_2T_4	0.55b	23.67a	7.33abc	5.33ab	13.30a	11.83a
V_2T_5	0.52bc	20.67defg	7.67abc	4.66bc	14.40a	11.60a
V_2T_6	0.55b	23.33ab	7.67abc	5.00ab	13.60a	10.96a
V_3T_0	0.27h	22.33abcd	8.33a	5.00ab	4.70c	2.83c
V_3T_1	0.37g	21.00cdef	8.32a	5.33ab	5.10c	2.83c
V_3T_2	0.54b	20.67defg	7.33abc	5.00ab	4.90c	2.83c
V_3T_3	0.66a	22.33abcd	8.31a	4.00cd	4.63c	2.93c
V_3T_4	0.41fg	21.33cdef	7.00bc	5.00ab	3.26c	2.63c
V_3T_5	0.48 cde	22.67abc	6.66cd	4.66bc	3.46c	1.73c
V_3T_6	0.45def	23.67a	7.00bc	5.00ab	4.46c	2.03c
LSD (0.05)	0.051	1.645	0.87	0.71	1.64	1.39
CV(%)	6.16	4.65	7.27	9.32	9.48	10.28

In a column, means followed by a common letter are not significantly differed of 5% level by DMRT
Variety: V_1 (*P. djmor*), V_2 (*P. ostreatus*), V_3 (*P. florida*)
Days of composted sawdust: T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

Table 3. Effect of variety on the thickness of pileus, diameter of pileus, length of stipe, diameter of stipe, biological yield and biological efficiency of oyster mushroom

Variety	Thickness of Pileus (cm)	Diameter of Pileus (cm)	Length of Stipe (cm)	Diameter of stipe (cm)	Biological yield (g)	Biological efficiency (%)
V_1	0.66ab	6.65b	2.06c	1.18b	49.01b	28.00b
V_2	0.70a	6.47b	2.27b	1.11b	50.12a	28.64a
V_3	0.62b	10.79a	4.60a	1.57a	48.57b	27.75b
LSD (0.05)	0.05	0.66	0.05	0.15	0.89	0.89
CV (%)	10.83	10.97	2.38	15.74	2.93	2.93

In a column, means followed by a common letter are not significantly differed of 5% level by DMRT
Variety: V_1 (*P. djmor*), V_2 (*P. ostreatus*), V_3 (*P. florida*)

Table 4. Combined effect of varieties and composting period of sawdust on the on the thickness of pileus, diameter of pileus, length of stipe, diameter of stipe, biological yield and biological efficiency of oyster mushroom

Treatments	Thickness of Pileus (cm)	Diameter of Pileus (cm)	Length of Stripe (cm)	Diameter of stripe (cm)	Biological yield (g/plant)	Biological efficiency (%)
V_1T_0	0.68abc	5.56e	2.17ij	1.24cd	50.03def	28.58def
V_1T_1	0.69abc	8.33d	2.23hi	1.41bc	53.53bc	30.58bc
V_1T_2	0.54cd	11.42bc	1.69k	0.83def	42.46h	24.26h
V_1T_3	0.72ab	5.42e	2.12ij	1.25cd	55.06ab	31.74ab
V_1T_4	0.59bc	5.26e	2.07ij	1.23cd	48.93efg	27.96efg
V_1T_5	0.72ab	5.44e	2.11ij	1.20cde	51.13cde	29.21cde
V_1T_6	0.57bc	5.11e	2.05j	1.13cde	49.20efg	28.11efg
V_2T_0	0.66abc	8.05d	2.35gh	1.71b	52.93c	30.24c
V_2T_1	0.70abc	7.53d	2.41g	0.73ef	42.13h	24.07h
V_2T_2	0.69abc	8.00d	2.63f	0.61f	46.70g	26.68g
V_2T_3	0.81a	5.520e	2.17ij	1.21cd	56.50a	32.28a
V_2T_4	0.64abc	5.55e	2.12ij	1.22cd	49.08efg	28.04efg
V_2T_5	0.72ab	5.37e	2.13ij	1.14cde	50.83cdef	29.04cdef
V_2T_6	0.66abc	5.27e	2.13ij	1.16cde	48.36fg	27.63fg
V_3T_0	0.69abc	11.50bc	5.02c	1.82b	53.06c	30.32c
V_3T_1	0.62bc	10.83c	4.70d	1.69b	41.16h	23.52h
V_3T_2	0.64bc	13.53a	5.29b	1.55bc	38.13i	21.78i
V_3T_3	0.40d	11.55bc	5.43a	2.35a	52.26cd	29.86cd
V_3T_4	0.65abc	7.42d	2.33gh	1.22cd	50.16def	28.66def
V_3T_5	0.74ab	7.47d	5.01c	1.17cde	51.93cd	29.67cd
V_3T_6	0.63bc	13.27ab	4.42e	1.23cd	49.86def	28.49def
LSD	0.14	1.76	0.14	0.40	2.35	2.35
CV(%)	10.83	10.97	2.38	15.74	2.93	2.93

In a column, means followed by a common letter are not significantly differed of 5% level by DMRT

Variety: V_1 (*P. djmor*), V_2 (*P. ostreatus*), V_3 (*P. florida*)

Days of composted sawdust: T_0 (0 day), T_1 (5 days), T_2 (10 days), T_3 (15 days), T_4 (20 days), T_5 (25 days), T_6 (30 days)

CHAPTER V

SUMMARY AND CONCLUSION

Commercial production of mushrooms mainly depends on the availability of cheap agricultural wastages which represents the ideal and most promising substrates for cultivation. The substrates used in this research can be considered practically and economically feasible under the temperate climatic conditions due to their availability throughout the year at little or no cost in large quantities. So that this experiment was carried out to find out the best composting period and species sawdust-based substrates for high yield of oyster mushroom. The experiment was conducted in the laboratory of the National Mushroom Development and Extension Center, Savar, Dhaka from July to December 2019. Three selected species of oyster mushrooms such as, *Pleurotus djamor*, *Pleurotus florida*, and *Pleurotus ostreatus* PO10 were cultivated in the culture house of the Mushroom Development Institute. Mushroom varieties used in the experiment were collected from germplasm Centre of Mushroom Development Institute (MDI), Savar, Dhaka. This was cultured in biotechnology laboratory and cultivated in the culture house of MDI. There were two factors in this experiment. Factor A: Variety, V_1 *(Pleurotus djamor*), V_2 (*(Pleurotus ostreatus* PO10*)* and V_3 *(Pleurotus florida).* And Factor B: Days of composted sawdust, T_0 (0 days), T_1 (5 days old), T_2 (10 days old), T_3 (15 days old), T_4 (20 days old), T_5 (25 days old) and T_6 (30 days old). The experiment was laid out following completely randomized design (CRD) with 3 varieties and 4 replications and each replication contain twenty-one populations. Data were analyzed following Gomez and Gomez (1984) using MSTAT-C computer program and Excel software. Means separation were computed following Least Significant Difference (LSD) using the same computer program. Different parameters were selected for data collection and data were collected on mycelium growth rate, time required for completing mycelium running, time required to primordial initiation, time required from pinhead initiation to 1st harvest, number of fruiting body, number of effective fruiting body, thickness of pileus, diameter of pileus, length of stripe, diameter of the stripe, biological yield and biological efficiency of oyster mushroom species.

In case of varietal variation, the fastest mycelium growth rate (0.54 cm) was observed in V_2 and the slowest was in V_3 (0.45 cm). The maximum days for completing mycelium running were found in V_3 (22.00 days) and minimum was in V_1 (21.29 days). The highest time (7.57 days) was needed for primordial initiation in V_3 and V_1 (7.14 days) was lowest. The maximum days were required from pinhead initiation to 1st harvest in V_3 (4.85 days) and minimum days were in V_1 (4.52 days). The highest number of the total fruiting body was found in V_2 (13.97) which was statistically similar to V_1 (13.46) and the lowest number of total fruiting body was found in V_3 (4.36). The uppermost number of the effective fruiting body was found in V_2 (11.43) while the lowest number was found in V_3 (2.54). The V_2 (0.70cm) had the most thickness, which was statistically similar to V_1 (0.64cm). In V_3, the pileus thickness was considered to be the thinnest (0.62cm). The largest dimension pileus was discovered in V_3 (10.79cm) while the V_2 (6.47cm) has the smallest. The longest stipe was found in V_3 (4.60cm), though the shortest stipe was found in V_1 (2.06 cm). V_3 (1.57 cm) had the highest stipe diameter, while V_2 had the lowest (1.18 cm). The V_2 produced the maximum biological yield (50.12 g). V_3 (48.57g) had the minimum biological yield, which was statistically comparable to V_1 (49.01g). Maximum biological efficiency (28.64%) was obtained from V_2 and the minimum (27.75%) was in V_3.

In case of days of composted sawdust, the maximum mycelium growth rate was recorded in T_3 (0.67 cm) and minimum was in T_1 (0.45cm). T_6 (23.00 days) showed the highest days for completing mycelium running and minimum was in T_3 (20.56 days). Maximum days from primordial initiation were required in T_0 (7.88days) and the minimum was in T_3 (6.66 days). The highest days from pinhead initiation to 1st harvest was found in T_2 (5.22days) and the lowest was in T_3 (3.77days). The maximum number of total fruiting bodies was found in T_3 (11.57), The minimum number of the total fruiting body was found in T_2 (9.178). The topmost number of the effective fruiting body was found in T_3 (9.21). The lowest number of the effective fruiting body (6.72) was found in T_2. The pileus thickness was found to be the thickest in T_5 (0.73cm). The smallest (0.62cm) pileus thicknesses were found in T_2 and T_6. The pileus with the largest diameter was discovered in T_2 (10.98cm). T_4 (6.07cm) had the smallest pileus diameter, which was statistically similar to T_5 (6.09cm) treatment. T_3 (3.24cm) had the longest stipe length range, which was statistically comparable to T_2 (3.20cm). The stipe length was found to be the shortest (2.17cm) in T_4. T_3 (1.60cm) had the largest stipe diameter, which was statistically similar to T_0 (1.59cm). T_2 has the stipe with the smallest (0.99cm) diameter. T_3 (55.00 g) had the highest biological yield. T_2 produced the least biological yield (42.43 g). T_3 produced highest biological efficiency (31.42%) and the lowest (24.24 %) was obtained from T_2.

In case of combined effect of variety and days of composted sawdust, the highest mycelium growth rate was recorded in V_1T_3 (0.68 cm) and the lowest was in V_3T_0 (0.27 cm). The maximum days for completing mycelium running were required in V_2T_4 (23.67 days), V_3T_6 (23.67 days) and minimum were in V_1T_2 (19.00 days). V_3T_0 (8.33 days) had highest time for primordial initiation and V_2T_3 (5.66 days) was the lowest. The maximum days from pinhead initiation to 1st harvest were required in V_2T_1 (5.66 days) and the minimum was in V_2T_3 (3.33 days). The maximum number of total fruiting bodies was found in V_1T_3 (15.26) and the minimum number of the total fruiting body was found in V_3T_4 (3.26). The largest number of effective fruiting bodies (12.46) was found in V_2T_3, while the poorest number of effective fruiting bodies (1.73) was found in V_3T_5. The pileus thickness was found the thickest in V_2T_3 (0.81cm) and the smallest (0.40cm) pileus thicknesses were found in V_3T_3. The pileus with the largest diameter was discovered in V_3T_2 (13.53 cm). V_1T_6 (5.11cm) had the smallest pileus diameter. The longest stipe length was found in V_3T_3 (5.43 cm), while the shortest stipe (1.69cm) length was found in V_1T_2. V_3T_3 (2.35 cm) had the largest stipe diameter and V_2T_2 has the stipe with the smallest (0.61cm) diameter. The combined impact of various mushroom varieties and days of composted sawdust showed a notable variation on biological yield. V_2T_3 (56.50 g) had the highest biological yield; the biological yield (38.13g) was the lowest in V_3T_2. The highest biological efficiency (32.28 %) was found in V_2T_3 and the lowest was found in V_3T_2 (21.78%).

Conclusion

Based on the result of the current study, it could be concluded that *Pleurotus ostreatus* showed the best performance among the studied varieties. The 15 days of composted sawdust gave the higher result among the planned treatments of the research in most of the cases.

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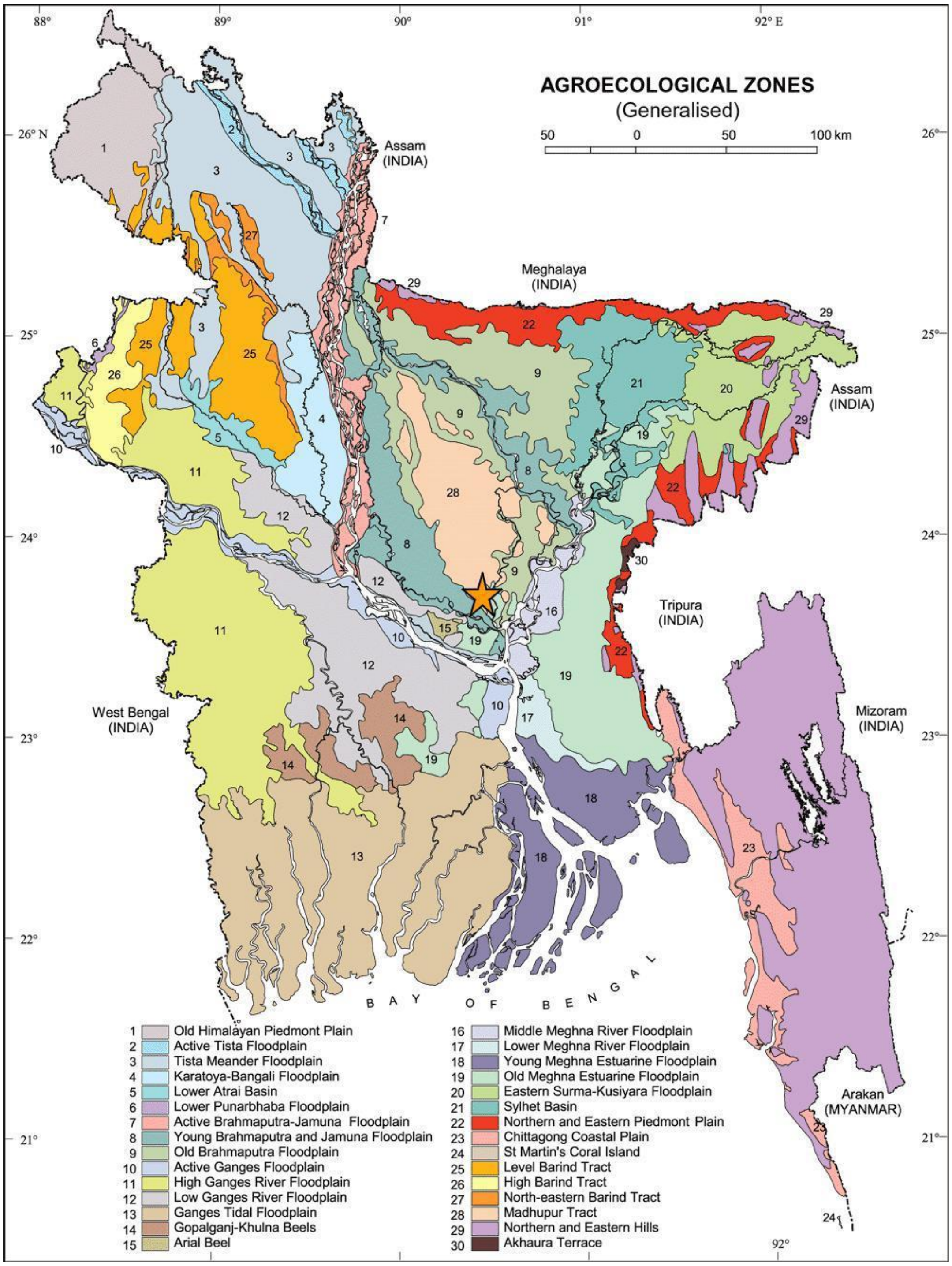
APPENDICES

Appendix I: Map showing the experimental sites under study.



☆ **The experimental site under study**

Appendix II. Analysis of variance of the data on the mycelium growth rate, times required for completing mycclium running, time required for primordial initiation, number of fruiting body, number of effective fruiting body of oyster mushroom varieties as influenced by sawdust composting period and their combinations.

Source of Variation	DF	Mean square values					
		Mycelium growth rate	Time required for completing mycclium running	Time from stimulation to primordial initiation	Days required from pinhead initiation to 1st harvest	Number of fruiting body	Number of effective fruiting body
Variety (A)	2	0.049**	2.714*	0.968^NS	0.587*	614.568**	523.392*
Age of compost sawdust (B)	6	0.056*	6.963*	1.460*	2.608*	5.215*	5.793*
Variety (A) x Age of compost sawdust (B)	12	0.011*	5.011*	1.468*	1.235*	5.642*	4.292*
Error	42	0.001	1.016	0.286	0.190	1.010	0.729

**Significant at 1% level of significance, *Significant at 5% level of significance, ^NS Non significant

Appendix III. Analysis of variance of the data on the thickness of pilues, diameter of pilues, length of stripe, diameter of stripe, biological yield and biological efficiency of oyster mushroom varieties as influenced by sawdust composting period and their combinations.

Source of Variation	DF	Mean square values					
		Thickness of Pilues	Diameter of Pileus	Length of Stripe	Diameter of the stripe	Biological Yield	Biological Efficiency
Variety (A)	2	0.020*	83.866*	27.735^{NS}	0.881^{NS}	13.352*	13.352*
Age of compost sawdust (B)	6	0.009*	17.455^{NS}	0.853*	0.308^{NS}	155.176**	155.176**
Variety (A) x Age of compost sawdust (B)	12	0.016*	4.871*	0.762*	0.186^{NS}	34.218*	34.218*
Error	42	0.005	0.765	0.005	0.041	2.087	2.087

**Significant at 1% level of significance, *Significant at 5% level of significance, ^{NS}Non significant.