Production of Oyster Mushroom Using Sterilized and Carbonized Fruiting Bags: A Comparative Study

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Abstract

The study was conducted for production of oyster mushrooms using sterilized and carbonized fruiting bags. Using these The study was conducted for production of oyster mushrooms using sterilized and carbonized fruiting bags. Using these agro-wastes as substrates in different mixture proportions, the productivity of oyster mushrooms was investigated in terms of the number of yields, mass, size, and height. An experimental research design was used to test the hypothesis of the significant difference in the yields and growth of oyster mushrooms between SPH-LS and CPH-LS. The percentage, weighted mean, ANOVA TEST, and two-tailed test were used to interpret the data gathered based on a comparative study of mushroom productivity in terms of the earlier mentioned variables.

The results showed that increasing the percentage of lye straw in the carbonized palay husks and the sterilized palay husks increases the yields, mass, size and height of oyster mushrooms. Substrates with sterilized palay husks 25% with lye straw 75% were the most suitable substrate formulas for the cultivation of oyster mushrooms. This substrate gave the highest value in the number of yields, mass, size, and height with a smooth, white, and wide in diameter fan shape cap, overlapping cluster, with slightly course gills running from the cap down below the elongated stem.

Analysis of data revealed that SPH-LS (25%–75%) is not significantly different ($p > 0.05$) from CPH-LS (25% – 75%) as both showed almost the same average height produce. However, compared with the other two CPH-LSs is more recommended. Carbon could be mixed with another substrate rich in cellulose to grow mushrooms. The results showed that increasing the percentage of lye straw in the CPH and the SPH increases the yields, mass, and size of oyster mushrooms. This means that the said mixture combination is effective for mushroom production; however, no significant effect in the height of the mushroom in different mixture proportions with ($P=0.015$) was recorded.

Notably, the substrate with 100% carbonized palay husks gave no harvest of oyster mushrooms in the entire 30-day period of study). It was also found that the increasing ratio of lye straw in the substrate closely correlates with the number of yields, mass, size, height, texture, and appearance.

There is a significant difference between the sterilized palay husk and carbonized palay husk as the fruiting oyster mushroom bag. It was revealed that the sterilized palay husk with lye straw produced a more significant amount of oyster mushroom in yield (piece), mass (gram), and size (cm) compared with carbonized palay husk but there is no significance in terms of height. Since that the production of oyster mushrooms using carbonized palay husk with lye straw was increased in terms of height. Therefore, the hypothesis of this study was partially accepted.

It is recommended to utilize of the efficiency of agro-wastes as the substrate in cultivating oyster mushroom. More specifically the 25 % sterilized palay husk with 75 %lye straw. It can harvest more amount oyster mushroom in terms of yields, mass, and size. However, it is more recommended to used 25% carbonized palay husk with 75 % lye straw in terms of height of oyster mushroom.

Keywords : substrate, cultivation, yield, proportions, sterilized, carbonized

1. Introduction

In 2000, the country passed the Republic Act 9003, also known as the "Ecological Solid Waste Management Act of 2000", creating a mechanism to control the proper disposal of waste and emphasizing the three Rs (i.e., Reduce, Reuse, and Recycle). Hence, instead of throwing away these wastes and polluting the environment, this can be bio-renewed and converted to their useful form by turning those into high valued organic biomaterials such as substrates in growing nutritious and medically important mushrooms (Sozbir, 2015).

Timely, this study utilized agro-wastes such as palay husk modified into carbonized palay husk and sterilized palay husk as oyster mushroom substrate. The Laguna province has a huge rice field area, particularly in Liliw and the nearby town. This favors the researcher to experiment using the sterilized and carbonized palay husk as a fruiting bag to compare the yield of oyster mushrooms.

The objectives of this study are to consider current practices for utilizing the waste rice straw and palay husks from rice production and to present ideas for developing their full utilization, including the carbonized palay husk and sterilized palay husk in different proportions with lye straw as a substrate of oyster mushroom cultivation. This served as a basis for determining the best substrate to be used by mushroom growers, giving an awareness to the ordinary farmers to save and utilize their agro-wastes (palay husk and lye straw) from burning instead. In addition, it can be used as another source of income as mushroom cultivation media.

According to Girmay (2016), mushroom cultivation technology can be used as bioremediation, maintaining the environment pollution-free. The mushroom mycelia produce a group of complex extracellular enzymes degrading and utilizing lignocellulosic wastes, thereby reducing pollution. As revealed from the study, mushroom mycelia have a significant role in the restoration of damaged environments (myco-restoration) through myco-filtration (using mycelia to filter water), myco-forestry (using mycelia to restore forests), myco-remediation (using mycelia to eliminate toxic waste), and myco-pesticides (using mycelia to control insect pests).

Rice straw and rice husk have traditionally been regarded as less value waste materials just left in the rice field for a long time to decompose and will serve as soil fertilizer and used to burnt to produce air pollution that may compromise human health and the environment. Just like the purpose of this study, the local government gave awareness and amended strict regulations governing these disposals. They have led to scientific efforts to identify potential uses for these materials, and various contributions to agricultural activities, energy generation, environmental pollution control, and construction materials have been identified and developed, and some of the main processes for utilization of rice straw and husks (Arai et al., 2015). Most agro-wastes are rich in lignocellulosic materials, which are essential for mushroom growth. According to Kamthan and Tiwari (2017), the oyster mushroom can break down lignocellulosic materials, and their cultivation represents an economical and environmentally friendly approach to the utilization of agricultural wastes like palay husk and lye straw.

Land availability is another factor why mushroom cultivation limits the novice mushroom grower. They have the insufficient background that mushroom cultivation requires relatively little space; they can be stacked using shelf-like culture systems. (Alam and Raza 2001; Sher 2006; Shah et al. 2004; Flores 2006, as cited in Girmay et al. 2016). A simple household can do cultivation of mushrooms even in their house, which can give an additional income. Furthermore, the yield of the mushroom can provide nutritious food for the family. Based on the studies conducted at the Institute of Science and Technology (INST), every 100 grams of mushroom intake can meet the body's daily nutritional requirements (Llanos, 2016).

Many Filipinos are unaware that cultivating mushrooms can provide a sustainable income. According to Icalina et al. (2014) and Medenilla (2020), the status and prospect of the mushroom industry in the Philippines have been exacerbated since 1995. Only 10 % can supply in local, and the lowest production volume was 355 metric tons (MT) in 2009. Most of the mushrooms consumed were imported from the different countries of Southeast Asia like China, Taiwan, Thailand, Malaysia, Korea, and Japan. Growing mushrooms in the Philippines is economically feasible due to low- production cost, an abundance of cheap substrates from agro wastes, and high demand, which will be profitable to the mushroom growers. In this study, Liliw community is oriented to generate income through utilizing agro-wastes (palay husk and lye straw) as a substrate of mushrooms and soon can be formulated and used as diverse wastes for mushroom cultivations.

Background of the study

The oyster mushroom (Pleurotus species) is the second widely cultivated mushroom. It is an edible, saprophytic, and lignocellulolytic type of fungus. (Sachez 2010 as cited by Paudel & Dhakal, 2019). Based on the report of Artek (2022), developing countries such as Bangladesh suffer much from a food uncertainty problem, mainly due to inadequate and imbalanced diet intake. The problem is further compounded by the country's rapid population growth.

Consequently, people, especially children and women, are experiencing chronic malnutrition. Since the country is agro-based, they used to utilize these by-products such as rice straw (RS), wheat straw (WS), corncobs (CC), saw dust, and rice husk @ 3:1 (SR) and sugarcane bagasse (SB) as a substrate for oyster mushroom. Their investigation revealed that there is enhanced growth of fruiting bodies, producing the biggest stalk and cap using rice straw (RS) as substrate. This might be since this mixture contains comparatively higher amounts of cellulose, hemicelluloses, and lignin, which might favor the growth and development of oyster mushrooms in the present study (Santos, Neto, Silverio, and Martin, 2013).

Likewise, the study performed by Dubey et al. (2019) utilized Among all the treatments, rice straw was observed most beneficial for mushroom cultivation in terms of yield than other substrates, banana leaves, wheat straw, and sugarcane bagasse.

Rice straw and husks have traditionally been considered waste materials of little value. However, increasingly strict regulations governing their dumping have led to scientific efforts to identify possible uses for these materials, and various contributions to agricultural activities, energy generation, environmental pollution control, and construction materials have been recognized and established, and some of the main processes for utilization of rice straw and husks (Arai el., at. 2015). These agro-wastes are rich in lignocellulosic materials, which are vital for mushroom growth. According to Kamthan and Tiwari (2017), oyster mushrooms can break down lignocellulosic materials, and their cultivation represents an economical and environmentally friendly method to utilize agricultural wastes.

Theoretical framework

The theoretical framework of this current study is based on using rice by-products, including the rice hull/husk and rice straw or lye straw as oyster mushroom substrate. The concept of the comparative study on yields of oyster mushrooms using sterilized palay husk with lye straw and carbonized palay husk with lye straw in terms of the number of yields, mass, size, and height are anchored in the theories of utilizing heat from rice hull biochar production for steam pasteurization of mushroom fruiting bags.

One of the schemes to improve the income of an ordinary farmer is by utilizing the rice by-products, including rice hull and rice straw, which studies oyster mushroom production in the Philippine Rice Research Institute (PhilRice 2018), which encourages the various and combines rice-based farming system called Palayamanan. Just like the procedure done with this study, Palayamanan used rice straws as the main substrate, which is soaked in water for 24 hours, drained and left for 2–5 days to decompose partially, and then chopped to 2–3 cm long.

The chopped straws are mixed with saw dust (30% by weight) and placed in 152 × 305 mm polypropylene plastic bags. Once filled with the desired weight or compaction of the substrate, averaging 750 g per bag, the mouth of the bag is inserted into a cut plastic pipe (12 mm dia × 10 mm length) and then folded back (sandwiching the cut plastic pipe) and tied with a rubber band to provide a cover and small opening for seeding the spawn after the steam pasteurization process. The steam pasteurization of the bags of substrate called mushroom fruiting bags (MFBs), is normally carried out in a 200-l steel drum using wood as fuel. After harvesting all the cultured oyster mushrooms (200–250 g per MFB), the spent and partially decomposed substrates then go to vermiculture production, where they are left to decompose and serve as feeds for the earthworms (Corales et al., 2004, as cited in Orge & Leal, 2018).

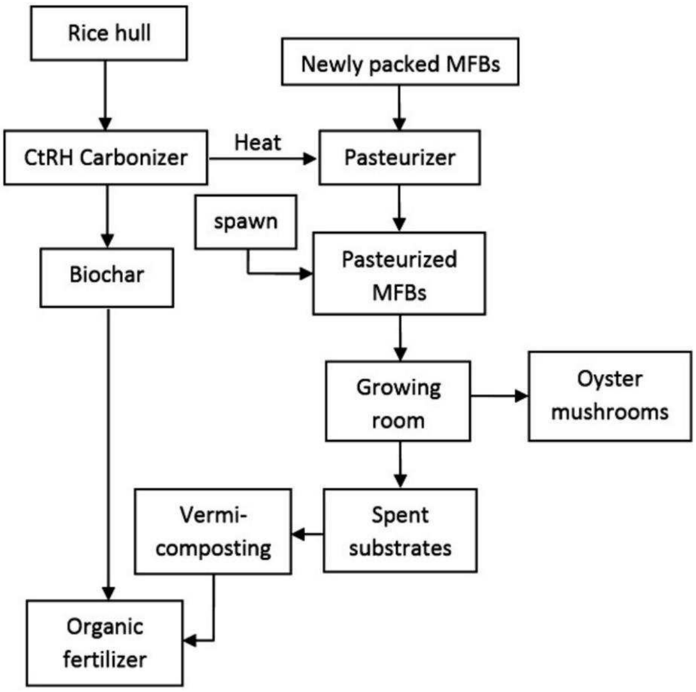

Figure 2. The use of the CtRH Carbonizer in the Production of Oyster Mushrooms within Palayamanan.

Likewise, in the study by Yang et al. (2013), a comparison between the sterilized substrate, and the non-sterilized substrate showed a higher mycelial growth rate, shorter total colonization period, and days from bag opening to primordia formation. However, the non-sterilized substrate did not give significantly higher mushroom yield and biological efficiency than the sterilized substrate, but some undesirable characteristics, i.e., smaller mushroom cap diameter and relatively long stipe length. In this study, the researcher compared the oyster mushroom production utilizing carbonized palay husk with lye straw and sterilized palay husk with lye straw fruiting bag.

Conceptual framework

The conceptual framework of this study was presented in the form of the paradigm below:

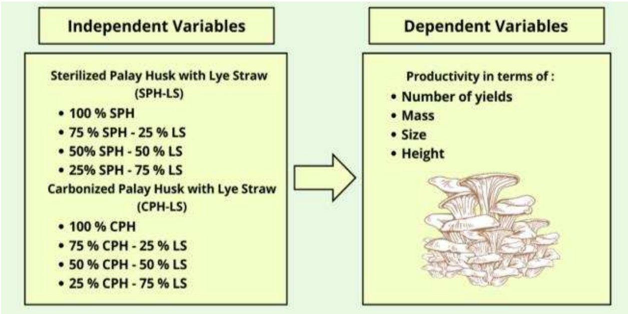

Figure 1. The Paradigm of the study

As shown in Figure 1, this study utilized the dependent and independent variables. Wherein it shows how the study was done. In the independent variable, the substrates are to be used to compare the number of yields, mass, size, and height of oyster mushrooms using the different mixture proportions of carbonized palay husk with lye straw (CPH-LS) and Sterilized Palay Husk with Lye Straw (SPH-LS).

Statement of the problem

The purpose of the study was to determine the number yields, mass, size, and height of oyster mushrooms (Pleurotus ostreatus) using different fruiting bags out of sterilized palay husk, carbonized palay husk, and lye straw. Specifically sought to answer the following questions:

1. What is the percentage level of mushroom productivity fertilized with a mixture of sterilized palay husks with lye straw at different proportion in terms of:
   1.1 number of yields
   1.2 mass, and
   1.3 Size?
2. What is the percentage level of mushroom productivity using a mixture of carbonized palay husk with lye straw at different proportions in terms of:
   2.1 number of yields
   2.2 mass, and
   2.3 Size?
3. Is there a significant effect on different mixture proportions on sterilized palay husk and lye straw in mushroom productivity?
4. Is there a significant effect on different mixture proportions of carbonized palay husk and lye straw in mushroom productivity?
5. Is there a significant difference in the mushroom productivity between SPH-LS and CPH and LS using

Hypothesis

In this study, the production of oyster mushrooms using sterilized and carbonized fruiting bags was compared and tested in terms of number of yields, mass, size, and height.

There is a significant difference between the sterilized palay husk and carbonized palay husk as the fruiting oyster mushroom bag. It was revealed that the sterilized palay husk with lye straw produced a more significant amount of oyster mushroom in yield (piece), mass (gram), and size (cm) compared with carbonized palay husk but there is no significance in terms of height. Since that the production of oyster mushrooms using carbonized palay husk with lye straw was increased in terms of height. Therefore, the hypothesis of this study was partially accepted.

Significance of the Study

Specifically, the result of this study will be very beneficial to the following:

Students. This study will be a great help and source for them to gain knowledge about the significant difference in the yield and growth of oyster mushroom (Pleurotus ostreatus) between palay husk and carbonized palay husk.

Future Mushroom Growers. This study will help the new generation of mushroom growers to acquire knowledge for innovating fruiting bags using different substrates from locally available resources in the community for the yield and growth of oyster mushrooms (Pleurotus ostreatus).

Households. This will make the households can be helped in providing nutritious organic food and can give a great source of income.

Future Researchers. Researchers will find the result and the strong, valuable evidence for the yield and growth of oyster mushroom (Pleurotus ostreatus) in an alternative study of using different fruiting bags from locally available resources in the community.

Scope and limitation of the study

2. This study focused on the comparison of the yields, mass, size, and height of oyster mushrooms (Pleurotus ostreatus). Thirty fruiting bags were produced in each proportion as a substrate of oyster mushroom using sterilized palay husk with lye straw (CPH-LS) and carbonized palay husk with lye straw (CPH-LS. The gathering of data in terms of the number of yields, mass, size, and height was started on fully colonized fruiting bags with the mycelium of oyster mushrooms. Acquiring data was sufficient in thirty days for the comparative study on yields of oyster mushrooms using sterilized palay hush and carbonized palay husk as a fruiting bag of oyster mushrooms.

3. The study was rendered in Brgy. Masikap Liliw, Laguna with thirty fruiting bags for sterilized palay husk and thirty fruiting bags for carbonized palay husk with a total of two hundred forty fruiting bags for each sample (100% CPH-LS; 75% CPH-25% LS; 50% CPH – 50% LS; 25% CPH – 75% LS and 100% SPH-LS; 75% SPH 25%LS; 50% SPH - 50% LS; 25% SPH- 75% LS).

The expected date to complete the study was not met due to the long preparation and suggested title revision. The researcher took 98 days to render the entire procedure of the experiment in comparative study on yields of oyster mushrooms using sterilized palay husk and carbonized palay husk as the fruiting bag. The researcher rendered necessary action to conduct this study. Starting from making the mushroom nursery room favorable to the oyster mushroom, acquiring materials needed, and intervention for conducting the experimentation up to the finalization of the manuscript. The big challenge faced by the researcher was providing a moist, dark environment yet well-ventilated nursery room for mushrooms. Knowing that the only ‘available place was in the front house-up on the terrace. This place is facing direct sunlight during the afternoon. The site was covered with a thick blanket, proofing insulator foam, providing the entire room with a mosquito net against pests, frequent watering in the surrounding and misting for 2-3 times a day, providing moist and coldness favorable to the oyster mushroom to grow.

Definition of Terms

In this study, the terms used are defined from the educational and operational points of view to help readers make the work comprehensive.

- Carbonized. This refers to the conversion of material into carbon or charcoal
- through the process of burning or fossilization.
- Cultivation. This refers to the process of producing of desired species.
- Inoculation. This refers to the injection or introduction of cultivated mushrooms in the fruiting bag.
- Incubation period. This refers to the sample or subject under close monitoring due to the process of infection of an individual.
- Fruiting bag. This refers to the lignin-rich cellulose that served as the food of the cultivated mushroom.
- Humidity. This refers to the moistness of air present in the surroundings.
- Lye straw. This is agricultural waste from the stalk of rice plants.
- Palay husk. This refers to the hard and porous covering of rice called ‘Ipa ng palay’.
- Production. This refers to the quantitative amount of product being produced.
- Productivity. This refers to the rate or speed of a product being produced.
- Sterilization. This refers to the process of terminating microorganisms through boiling or the application of heat.

4. REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents the related literature and related studies which are found to have significantly guided of the specific research.

4.1 Related Literature

Mushroom is a macro fungus with a distinctive fruiting body that can be either epigeous or hypogenous and large enough to be seen with the naked eye and picked by hand. A mushroom is an enlarged complex above the fleshy fruiting body of a fungus (such as a basidiomycete) that typically consists of a stem bearing a pile use, especially: one that is edible (Merriam Webster). In addition, mushrooms with other fungi are something special in the living world, being neither plants nor animals. Therefore, they have been placed in a kingdom of their own called the ―kingdom myceteae. Mushroom lack chlorophyll, unlike plants, undergo photosynthesis to get energy from the sun; instead, it secretes enzymes that break down and absorbs cellulose and lignin from the substrate.

The oyster mushroom is grown under natural conditions on living trees as a parasite or dead woody branches of trees as a saprophyte and primary decomposer. Therefore, the cultivation of oyster mushrooms on agricultural wastes provides multi-disciplinary advantages for humans, animals, and the ecosystem (Tsegaye, 2015). In this study, the research used agri-wastes utilizing palay husk into sterilized and carbonized as substrates of oyster mushroom.

According to Ighbareyeh (2021), mushroom cultivation was first started in 1630 in France. A Series of studies and experimentation on cultivating mushrooms was rendered afterward, monitoring the different mushroom growth and species. They also observed and found the best substrates for the mushroom to grow. They use sawdust, composting materials, straw, garbage, and agricultural wastes such as lye straw, palay hush, coconut husk, coconut shell, and bagasse.

Based on the study of Thi Hoa (2015), the Pleurotus species have fast-growing ability and need a short period to grow. Diseases and pests do not often attack the fruiting bodies. Pleurotus species require carbon, nitrogen, and inorganic compounds as their nutritional sources. The main nutrients are more carbon and less nitrogen. Oyster mushrooms can grow on the substrate of any materials containing cellulose, hemicellulose, and lignin, such as rice and wheat straw, cotton seed hulls, sawdust, wastepaper, leaves, and sugarcane residue. However, the yield and the quality of oyster mushrooms depend on the chemical and nutritional content of substrates.

As cited by Naraian, Ram, and Singh (2016), mushroom industries are quite promising worldwide due to the easy and manageable innovation and accessibility and diverse materials needed in cultivation, and many species are favorable for the climate. In 1917 German rendered the first experimentation with P. ostreatus cultivation. The mycelium was successfully grown in tree stumps and wooden logs and could harvest fresh oyster mushrooms. Furthermore, sawdust was used as the substrate for P. ostreatus for the first time in the laboratory. The sawdust was mixed with oatmeal to cultivate mushroom and found the best substrate using eucalyptus and pine sawdust. They observed abnormalities in the growth of mushroom due to insufficient light condition and found temperature ranging 10-310C is best for mushroom growth.

Based on the article report of Ladli, (2020) India in 1962, used paddy straw as substrate for cultivating P. flacellatus. They utilized corncobs as a preliminary alternative substrate in the cultivation of P. ostreatus. Although the Hungarian method was still patented in 1969, they used the sterilization technique for growing mushrooms. The method of application of thermophilic microorganisms in the fermentation of substrate used for the cultivation of P.ostreatus. They continuously developed and innovated the substrate used for the cultivation of P. ostreatus. Various substrates, including wheat and banana pseudostems, was also used. Using cotton waste from the textile industry was successfully developed in the cultivation of P. sajor-caju.

Based on the article review of Raut, (2019) in 2014, Mandandhar reported that oyster mushroom cultivation began in 1981 in Nepal. They used substrate out of chopped straws and flowers for the cultivation of mushrooms. Innovations made in oyster mushroom cultivation were grown into worthwhile investments and were dispensed to farmers. Their government gave the common farmers the same hazard for mushroom cultivation, even in small-scale regions, to complement their earnings and alleviate poverty.

Girmay, (2016) was conducted another examination to assess which is an ideal substrate to be used in mushroom cultivation at Wondo Genet College of Forestry and Natural Resource. Using four substrates (cottonseed, paper waste, wheat straw, and sawdust) had been investigated for their efficacy in oyster mushroom production. The pure culture of oyster mushrooms changed into attained in the Mycology Laboratory, Department of Plant Biology and Biodiversity Management, Addis Ababa University. Using an aseptic technique for oyster mushroom cultivation had shown increased and improved the mushrooms in daily monitoring. The oyster mushroom was produced in differing increased yields using cottonseed, paper waste, sawdust, and wheat straw.

Another study rendered and evaluated by Paudel and Dhakal (2019) for the yield and related attributes of Pleurotus ostreatus using five substrates, namely rice straw, maize husks, banana leaves, finger millet husk, and the mixture of rice straw & black gram pod shell (1:1). Using standard cultivation practice, they used steaming sterilization technique. Spawning was installed these revealed that the biological efficiency and earliness of crop the performance of finger millet husk, followed by rice straw was found to be better.

One of the substrates used by the research is the rice husk, or rice hull is the coating on a seed or grain of rice. According to Goodman (2020), enable the mushroom to grow, the substrate must be composed of organic matter such as cellulose, lignin, etc., and mineral components such as silica, alkali, and trace elements. Favorably, the rice husk is abundant in the locality of the researcher that can be used as the major component of the substrate in a comparative study on yields of oyster mushrooms using sterilized palay husk and carbonized palay husk as the fruiting bag.

Aside from the environment, moisture, sunlight, and temperature, the composition of the substrate used for a fruiting bag can alter the productivity of mushrooms. An investigation was rendered by putting up the different proportions of CPH-LS and CPH-LS under the same treatment. Same with the findings in the study of Portillo (2018) that the rice straw is the most effective among the three substrates (rice stalk, rice straw, and rice husk). The experiment has 15 fruiting bags for each substrate sample none of the fruiting bags of rice straw have been contaminated, which is why it has a higher yield than rice husk and rice stalk. It is also found that rice husk has been used effectively as an additive when growing P. ostreatus in the study conducted by Frimpong-Manso et al. (2018)

The study of Kalaw and Albinto (2015) about the mycelial growth, and fruiting body production of five Pleurotus species grown on rice straw-based substrate using two substrate formulations, namely: 7 parts composted rice straw + 3 parts saw dust (v/v) and 7 parts composted rice straw + 3 parts carbonized rice hull (v/v) were evaluated. The result of the study was rice straw + sawdust formulation registered significantly shorter incubation period while no significant difference in the number of days to primordia formation, yield, and biological efficiency was observed between the two substrates formulations. Among the five Pleurotus species evaluated, Pleurotus Florida significantly recorded the shorter incubation period and the number of days to primordia formation, higher yield, and biological efficiency. In comparison, Pleurotus cystidiosus significantly registered a longer incubation period, number of days to primordia formation, lower yield, and biological efficiency.

Likewise, with the studies mentioned above, this research investigated the productivity of oyster mushrooms using sterilized palay husk and carbonized palay husk both with lye straw under the same treatment such as well-ventilated room, humidity, and sunlight. Specifically, to compare the yield, mass, size, and height for each mixture proportions of SPH-LS and CPH-LS. The researcher also has a chance to observe the appearance, texture as well as incubation period of mycelium using the two different substrates in each mixture proportion.

4.2 Related Studies

Mushrooms are usually grown on waste materials like palay husk and lye straw. These agro-industrial waste mainly consists of cellulose, hemicellulose, and lignin, all collectively defined as lignocellulosic materials. This waste can serve as a suitable substrate in mushrooms' solid-state fermentation process. Mushrooms degrade lignocellulosic substrates through lignocellulosic enzyme production and utilize the degraded products to produce their fruiting bodies Kumla, 2020).

In Germany, the oyster mushroom was first cultivated by Flank in 1917. According to Oloke and Adebayo (2015), an evolutionary connection among species in the Pleurotus is still unclear, and many taxonomic issues remain controversial. Nevertheless, the genus Pleurotus is one of the most diverse groups of cultivated mushrooms and shows a typical life cycle of Basidiomycetes.

As cited in the study of growth and cultivation of oyster mushroom Nongthombam et al., (2021) Miles, (2004) stated that mushroom cultivation was first investigated and observed the different growth parameters of mushrooms. Then, a series of studies were performed in France around 1630, using sawdust, composting materials, straw, and garbage.

Substrates usually are organic materials rich in ligno-cellulosic and come from farm waste in which mycelium growth can spread and produce mushrooms. Substrates used include sawdust, rice bran, rice straw, wheat bran, and wheat straw (Khare 2018).

The accessibility of good substrate is an essential constraint for the better growth and higher yield of mushrooms. A good substrate should comprise adequate nitrogen and carbohydrates for fast mushroom growth (Khare et al., 2010). Total Carbon (C), total nitrogen (N), and Carbon/Nitrogen ratio (C/N) are essential factors that control the mycelium colonization and development of fruiting bodies in oyster mushrooms. Substrate formulation is the most vital stage in the production process to ensure the occurrence of diseases is to a lesser extent with better yield (Jongman et al., 2010). The researcher chose carbonized palay husk and sterilized palay husk as the substrate for oyster mushroom fruiting bags. The probability of getting disease and contamination of mushrooms will be lessened.

As of today, oyster mushrooms are the third leading cultivated mushrooms. China, the world leader in Oyster production, provides nearly 85% of the total world production of about a million tons. The other countries producing oyster mushrooms include Korea, Japan, Italy, Taiwan, Thailand, and the Philippines. Mushroom cultivation has been in the Philippines since the 19th century but unfortunately, only 10% of the local mushroom contribution can be supplied due to a lack of awareness on cultivating mushrooms (Medenilla, 2020).

The most common agricultural wastes in the Philippines are rice husk, rice straw, coconut husk, coconut shell, and bagasse. The country has a great capacity for biomass power plants as one-third of the country's agricultural land produces rice, and consequently, large volumes of rice straw and hulls are generated (Zafar, 2021). These agro-wastes have great potential in mushroom cultivation. The rice straw and its hulls contain a combination of cellulose, hemicellulose, and lignin, along with appreciable amounts of silica and other minor components.

The waste from productive agro-industrial materials, e.g., rice straw, wheat straw, bagasse (sugar cane residue), cotton seed hull, corn stalks, sorghum stalks, and even wild grasses, can be utilized as the primary component of the compost for the cultivation of the mushroom. Using this as the substrate of mushrooms has low- production costs and makes it more profitable to the mushroom growers as it continuously increases demand in the Philippines.

It should be stated that these materials must be air dried first and then blended with cattle dung, poultry manure, and some chemical fertilizers. Just like the researcher's preparation of the substrates for oyster mushrooms, the Asian and Pacific Centre for Agricultural Engineering and Machinery (APCAEM) (2015) created many formulas for the composition of the substrate. The substrate composition is based on the accessibility of the ingredients from place to place and country to country depending upon the raw materials available, and local climatic conditions must be considered in cultivating mushrooms.

Advanced technology is used in the preparation of the fruiting bag. First, the APCAEM mixed the dry ingredients by hand or with a mechanical mixer. Then, the same with the moisture of substrate formulated by the researcher to conduct this study, water is added to the mixture so that the final moisture content of the substrate is between 55 and 60%, depending on the capacity of the sawdust to absorb water. Although the bags have been filled with the substrate (1.5 to 4 kg wet weight, w/w), the end of the bag can be closed either by strings or plugged with a cottonwool stopper. The most popular since polypropylene provides greater clarity than polyethylene. Instead, the ingredients were prepared and packed into autoclavable polypropylene or high-density polyethylene bags.

The researcher used the same procedures in making fruiting bags using CPH-LS and SPH-LS in different proportions since they are abundant in the locality. Sterilization and aseptic technique were used in the preparation of fruiting bags instead of the autoclave process. The polypropylene bag was filled with the CPH-LS and SPH-LS in different proportions weighing one kilogram for each fruiting bag.

Rice straw is a popular substrate for Pleurotus cultivation in Asia, mainly favored for its composition of slow degrading carbohydrates. Rice straw has the chemical composition of percentage dry mass basis) 0.96% N, 73.01% PDF, 41.59% ADF, 31.42% Hemicellulose, 33.35% Cellulose, and 4.84% Acid detergent lignin when sampled over different stages of growth, amounting to a generalized carbon(lignocellulosic)-nitrogen ratio of 72% (Sarnklong et al. 2010). Rice straw is one of the most common substrates used for growing mushrooms. In the Philippines, around 11.3 million metric tons (PhilRice 2016) of rice straw are produced annually, used as a feed supplement for livestock, and as mulching materials.

Based on the study by Yang et al. (2013), both sterilized substrate and non-sterilized substrate, oyster mushroom on rice straw and basal wheat substrate have faster mycelial growth rate, comparatively poor surface mycelial density, shorter total colonization period, and days from bag opening to primordia formation, lower yield and biological efficiency, lower mushroom weight, longer stipe length and smaller cap diameter than that on cotton seed hull basal substrate. The addition of cotton seed hull to rice straw and wheat straw substrate slowed spawn running, primordial development, and fruit body formation. However, increasing the cotton seed hull can enhance the uniformity and white of mycelium, yield and biological efficiency, raise mushroom weight, and enlarge cap diameter and shorten stalk length. The non-sterilized substrate had a comparatively higher mycelial growth rate, shorter total colonization period, and days from bag opening to primordia formation than the sterilized substrate. However, the non-sterilized substrate did not give significantly higher mushroom yield and biological efficiency than the sterilized substrate, but some undesirable characteristics, i.e., smaller mushroom cap diameter and relatively long stalk length.

The investigation of Zhang et al. (2018) shows that the size of straw used as substrate in the oyster mushroom directly affects its yield. The size reduction methods used in straw are grinding and chopping. The ground straw yielded a higher mushroom growth rate and yield than the chopped straw. The growth cycles of mushrooms with the ground substrate were five days shorter than with the chopped straw for similar particle size. However, it was found that when the straw was ground into too small particles, the mushroom yield decreased. Zhang et al (2018) also found that rice straw yielded 10% more mushrooms than wheat straw under the same cultivation conditions.

Along with the studies mentioned above, the researcher also utilized agro-wastes as a substrate in the production of oyster mushrooms. Appearing in this research is using different mixtures proportion formulated (100% SPH, 75% SPH- 25% LS, 50% SPH-50% LS, 25% SPH-75% LS and 100% CPH, 75% CPH- 25% LS, 50% CPH- 50%LS, 25% CPH- 75% LS) to compare the yields, mass, size, and height of oyster mushroom. Based on the result of this study, the SPH-LS is a more ideal substrate compared with CPH-LS in terms of the number of yields, mass, and size. In terms of height of oyster mushrooms produced by the substrate of CPH-LS revealed that the height of mushrooms is higher compared with fruiting bodies produced in SPH-LS.

5. RESEARCH METHODOLOGY

This chapter discusses the research design used, tested the hypothesis and instrumentation, gathered data, implemented the steps of the experimentation, and the statistical treatment of the data trials and revisions and production cost.

3.1 Research Design

The researcher used an experimental design. The design of this study is experimental because the researcher wanted to compare the production of oyster mushrooms using sterilized palay husk with lye straw and carbonized palay husk with lye straw as the fruiting bag. According to Arikunto, as cited by Washu (2014), an experimental study aims to know whether or not the effect of the variable studied. In connection with this, Ary says that experimental design refers to the conceptual framework within which the experiment is conducted. The most integral part is that the design is applicable for testing the study's hypothesis.

The study utilized an experimental method of research wherein the researcher compared the production of oyster mushrooms in terms of the number of yields, mass, size, and height using carbonized palay husk with lye straw and sterilized palay husk with lye straw in different proportion.

Specifically, the fruiting bags gave an equal treatment under the same humidity, and sunlight and the intervention rendered during the experiment was unbiased and estimated the average treatment effect on productivity in terms of the number of yields, mass, size, and height.

3.2 Research Location

The location and resources are accessible in a place that was comfortable for the researcher during the implementation period. The nursery area of mushrooms was put up and located at the terrace area of the researcher at 007 Pasasao Street, Brgy. Masikap Liliw, Laguna. It is less than a 45-minute drive from the Laguna State Polytechnique University-Main Campus Sta. Cruz, Laguna.

3.3 The subject of the Study

The researcher made a fruiting bag out of palay husk and lye straw available to the nearest location. The rice husk can be used as a mixed feed, litter, mixed in the soil as fertilizer, burned, or ashes are used as growing media of mushrooms (Suriamihardja 2015). These served as the substrate of oyster mushrooms used in the comparative study on yields of oyster mushrooms using sterilized palay husk and carbonizing palay husk as the fruiting bag. In this study, the researcher made different proportions of carbonized palay husk with lye straw (100% CPH, 75% CPH- 25% LS, CPH 50%- LS 50%, CPH 25% - 75% LS) and sterilized palay husk with lye straw (100% SPH, 75% SPH -25% LS, 50% SPH- 50% LS, 75% SPH- 25% LS).

Each proportion of substrate had thirty fruiting bags. This was to compare the effect of the substrate used on the number of yields, mass, size, and height under the humid air, sunlight, and treatment. The researcher gathered pertinent data in terms of the number of yields in pieces, mass in grams, size, and height in centimeters. The daily activities were supported with photos during the entire experimentation.

3.4 Research Procedure

Initially, the researcher proposed the study entitled "Production of Oyster Mushroom Using Sterilized and Carbonized Fruiting Bag fruiting bags: A Comparative Study" at the LSPU Sta. Cruz Campus to conduct the study. After the panelist approved the study, the researcher began the study and prepared the nursery room for oyster mushrooms, acquired the materials needed, and rendered all the procedures.

3.4.1 Preparation of Lye Straw for the mixture of CPH and SPH

In preparation of sterilized palay husk with lye straw, the lye straw was obtained from the one rice field located at Brgy. Palina Liliw, Laguna. It was chopped into smaller pieces about two to three inches, then soaked in water with an agricultural lime solution for twenty-four hours. This helped to increase the pH level of lye straw. Then, thoroughly rinse and remove the excess water. This was sealed in a big plastic bag to decompose for another seven days. This allows the carbon and nitrogen released from the lye straw, an essential nutrient for oyster mushroom growth. The lye straw was drained, leaving at least forty percent of moisture. Mushrooms need an environment that has high humidity to avoid water loss. Mushrooms breathe and exchange gases with the atmosphere, so it is possible to "drown" mushrooms. (Allman, 2018)

3.4.2 Preparation of Sterilized Palay Husk with Lye Straw

The next procedure was weighing the lye straw and sterilizing palay husk to acquire the specific proportion needed in the study.

The palay husk to be sterilized was obtained from a rice mill in Brgy. Bungkol Liliw, Laguna. The preparation of the sterilized palay husk started with soaking it with lime for twenty-four hours, then it was thoroughly rinsed with water before boiling it. Before boiling, the palay husk was mixed with one liter of molasses and fermented fruit juice (optional) in water. Molasses and fruit juice can be used as a main energy source and addition of 5% molasses for the substrates to improve the mushroom growth, yield and biological efficiency (Afify et al. 2012). Frequent mixing is needed in this process. The excess water was drained after boiling. At least forty percent of water was left in the mixture. Set aside until it was cooled.

Table 1. Percentage of Sterilized Palay Husk (SPH) with Lye Straw (LS) as Substrate Used in Oyster Mushroom Fruiting Bag

Number Fruiting Bag	Percentage of Sterilized Palay Husk (SPH) with Lye Straw (LS)
30	100 % SPH
30	75% SPH - 25% LS
30	50% SPH – 50% LS
30	25% SPH – 75% LS

3.4.3 Preparation of Carbonized Palay Husk

In preparation for carbonized palay husk, palay husk was burnt and extinguished the fire with water. Then the carbonized palay husk was drained, removing the excess water and leaving at least forty percent moisture. The carbonized palay husk, palay husk, and lye straw were weighted to acquire the different proportions of substrate used as fruiting bags.

The fruiting bag for carbonized palay and lye; and palay husk and lye straw were thoroughly mixed before bagging. The used substrates in different proportions were thoroughly mixed and well-packed in high density in a Polypropylene bag (PP bag) with .03mm thickness. Each fruiting bag was adequately labeled with a specific proportion of the substrates used.

Packed or bagged fruiting bags were sterilized for eight hours upon boiling. Then was cooled overnight.

The aseptic technique was rendered during the installation of oyster mushroom spawn and was placed in a sterilized area to prevent contamination. The researcher frequently observed the appearance of mycelium in the fruiting bags for almost a month. The fruiting bags hanged once fully colonized by mycelium for easy stalk and opened to allow the fresh air exchange and room for the mushrooms to grow.

The fruiting bags were misted on the opening of the fruiting bag and watered of the surroundings at least three times a day when the weather is warm and once a day in cold weather to ensure the humidity of the surrounding favorable for growing mushrooms. After one week of the same intervention given of the fruiting bags, pinhead came up and matured oyster mushroom was harvested after 24-48 hours.

Table 2. Percentage of Carbonized Palay Husk (CPH) with Lye Straw (LS) as Substrate Used in Oyster Mushroom Fruiting Bag

Number Fruiting Bag	Percentage of Carbonized Palay Husk (CPH) with Lye Straw (LS)
30	100 % CPH
30	75% CPH - 25% LS
30	50% CPH – 50% LS
30	25% CPH – 75% LS

The study started with the preparation of the materials needed and growing last April 30, 2021. The lye straw and palay husk were soaked in the water solution with agro-lime to decompose for seven days. After decomposing, it will be rinsed and dried, leaving at least 40% moisture. On the 20th of May 2021, the researcher weighed the palay husk, lye straw, and carbonized palay husk to procure different proportions as substrate in the fruiting bag. Each proportion has thirty fruiting bags, 30 samples of fruiting bags with Palay Husk (PH) with Lye Straw (LS) (100% PH; 75% PH and 25% LS; 50% PH and 50% LS and 25% PH and 75% LS) and Carbonized

Palay Husk (CPH) with Lye Straw (LS) (100% CPH; 75% CPH and 25% LS; 50% CPH and 50% LS; 25% CPH and 75% LS). The bagged fruiting bags were placed in the big drum for the sterilization process for eight hours and was cooled overnight.

After thirty-eight days of preparation, the installation of oyster mushroom spawn using an aseptic technique was done. Before hanging the fruiting bags, the researcher waited for twenty-two days for the inoculation period, ensuring it was fully colonized with mycelium of oyster mushroom. Next, the researcher ensured the moisture on the fruiting bags and its surrounding through misting and fogging three times a day. Finally, on the 25th of June, a pinhead of oyster mushroom was sprouted on the fruiting bag. The researcher has recorded the needed data for a month since then.

3.5 Research Instrument

The researcher gathered pertinent data in terms of the number of yields counted on the matured and harvested oyster mushrooms. The researcher used a weighing scale to weigh the mass of harvested mushrooms using the unit in grams. The measuring material used was tape measure for the size and height. And direct observation of the mushroom for the texture and appearance was rendered every day by the researcher. The timetable was utilized to guide the researcher in monitoring and recording the data from each substrate proportion of fruiting bag under the same treatment.

As the proposed project was started, the researcher implemented the steps religiously as planned. Although oyster mushrooms thrive in any kind of climate, a certain temperature was kept and maintained the high humidity of the air to keep the mushrooms productive.

The proponent also considered location and peak season when mushrooms would be grown fast and more productive. For this reason, the proponent has decided to place the mushroom growing house at Barangay Masikap, Liliw, Laguna. In addition, necessary steps were taken to compare different proportions of substrates under the same treatment effectively.

The table below discusses the estimated calendar activities in this study. It started last April 2021 with the title proposal and ended with the final draft and publication until November 2021. Since the time frame exceeds the semester, the researcher and the thesis adviser have agreed to continue collecting the necessary data needed to accomplish this study.

Table 3. Schedule of the Activities in the Production of the Production of Oyster Mushrooms Using Sterilized and Carbonized Fruiting Bags.

Activities	Month1	Month2	Month3	Month4	Month5	Month6	Month7
Submission thesis proposal	April 2021	May 2021					
Revision of thesis proposal	April 2021	May 2021					
Implementation of research proposal preparing all the materials needed and fruiting bags using different substrates		May 2021	June 2021	July 2021			
Collection of Data					Jul-Aug 2021		
Computation and interpretation of Results						Oct 2021	
Initial Draft of Completed Paper							Nov 2021
Checking and Revisions							Nov 2021
Final Draft and Publication							Nov 2021

Table 4 below shows the steps in the preparation of substrate used in the study of a comparative survey of yields of oyster mushrooms using sterilized palay husk and carbonized palay husk as the fruiting bag. The actual procedure during experimentation lasted for ninety-eight days.

Table 4. Time Frame of Plan to Study to in the Production of the Production of Oyster Mushrooms Using Sterilized and Carbonized Fruiting Bags.

Steps in Production of Oyster Mushroom Using Sterilized and Carbonized Fruiting Bags: A Comparative Study	Time Frame
Acquired all materials needed	14 days
Chopping of lye straw	2 days
Soaking the palay husk and lye straw in water with lime	1 day
Decomposing the palay husk and lye straw	7 days
Boiling palay husk with molasses	1 day
Weighing and bagging or packing the mixed substrates	2 days
Sterilization and cooling process	1 day
Inoculation process	2 days
Oyster mushroom mycelium propagation	30 days
Hanging the fruiting bags (Simultaneous misting and fogging watering of the surrounding once the fruiting bag was opened.)	1 day
The appearance of pinhead after the fruiting bags was hanged	7 days
Collection of pertinent data based on the number of yields, mass, size, height, texture, and appearance of the oyster mushroom from experimental fruiting bag using different proportions of substrate used.	30 days

Table 5. Materials Used in in the Production of the Production of Oyster Mushrooms Using Sterilized and Carbonized Fruiting Bags.

Tools and Equipment	Specification	Function
Used iron drum	180000 kg	Sterilization container of fruiting bags
Deep pail	1000 liters	Measuring tool and for replenishing and removing water during soaking of the substrates

48x 24 polypropene plastic bag	10 pcs	Storage of palay husk and lye straw while soaking and decomposing.
Mosquito net	10 yards	The barrier which protects mushrooms against infestations.
Insulator foam	10 yards	Good insulator protected mushroom nursery room against high temperature from sunlight radiation.
78x 48 Blanket	3 pcs	Kept the mushroom nursery room dim and moist.
Bamboo	3 pcs	Attached and kept the mosquito net in place.
2x2 coco lumber	3 pcs	Ceiling frame
Sprayer	500 ml	Served as a misting sprayer in fruiting bags
1-inch hose	10 m	Watering system in nursery mushroom area
Weighing scale	10 kg	Weigh the substrate to acquire appropriate proportions of fruiting bags
24 inches Iron rod	16 pcs	Joint of the fruiting bag inside the drum during sterilization
Flat angle bad iron	3 pcs	Frameline for fruiting bags to hang on
Welding machine	1 pc	Used to create nursery mushroom room
Welding rod	2 pcs	Used for welding irons
LPG gas	1 tank	Energy used for sterilization process of CPH-LS and CPH-LS
Heavy-duty range	1 pc	A mechanical device used to sterilize CPH-LS and CPH-LS
Hollow blocks	3 pcs	Used as base and platform for drum during sterilization

Table 6. Supplies and Materials in in the Production of the Production of Oyster Mushrooms Using Sterilized and Carbonized Fruiting Bags.

Materials	Quantities	Use
Lye straw	10 sacks	Substrate mixture for fruiting bag
Palay hus1k	3 sacks	Substrate mixture for fruiting bag
Carbonized palay husk	3 sacks	Substrate mixture for fruiting bag
Agro-lime powder	6 kilos	Remove the acidity of lye straw and palay husk
Tap water		For soaking, cleansing, and rinsing, misting and wetting the surrounding nursery room of mushroom
Molasses	1 liter	Fertilizer of oyster mushroom
Oyster mushroom spawn	1 kg	Seed of oyster mushroom to be installed after sterilization process of fruiting bags
6x18 Polypropylene bag (PP bag) with .03mm thickness	300 pcs	Container of the mixed substrate of fruiting bag
Sterilized cotton balls	300 grams	For sealing and serving as protection against contaminants on inoculated fruiting bags, this allows air ventilation of fruiting bags
Rubber band	180 pcs	For sealing of fruiting bags
2x3 Sterilized used paper	180 pcs	Used for sealing the fruiting bag.
70% Isopropyl Alcohol	500 ml	For sterilization of inoculation area
Matches	1 pc	For sterilization during the inoculation process
Candle	1 pc	For sterilization during the inoculation process
Iron chopstick	1 pc	For sterilization during the inoculation process

3.6 Trial and Revision

In preparing different proportions of the substrate, the researcher encountered problems and difficulties during experimentation and investigation.

Table 7. Trial and Revisions Made

Trials	Effect	Reason	Revisions made
Producing and creating own fruiting bags.	Instead of oyster mushroom (Pleurotus ostreatus) was spouted, the Lawyer's wig (Coprinus	Erroneous spawn delivered from the online store	New fruiting bags were produced using the excess substrate.

	comatus) grown		Ensuring the accurate percentage of each substrate.
The approved research proposal was rejected.	Over whole revision on the title and study. Prolong timeframe of conducting research	Instead of using ready-made fruiting bags for the study, making DYI fruiting bags using SPH-LS and CPH-LS in different proportions was much more acceptable for conducting this study.	A change of research study was rendered.
Placing of fruiting bags on the terrace	Drying out of the fruiting bags directly affects the yields of mushroom	The researcher's available place as a mushroom nursery room was exposed to light and heat coming from the sun.	Frequent watering of the surroundings and misting three-four times per day

Table 8. Production Cost

Materials	Quantity	Unit Price (Php)	Total Price (Php)
PP Bag	200 pcs	1.16	232.00
Agro-Lime	6 kgs	50.00	300.00
30x50 Plastic	10 pcs	28.25	282.50
Drum	1 pc	700.00	700.00
Molasses	1 litre	70.00	70.00
Oyster mushroom spawn	1 kg	210.00	210.00
Sterilized cotton balls	200 pcs	25.00	35.00
Rubber band	300 g	35.00	35.00
2x3 Sterilized used paper	180 pcs	10.00	10.00
70% Isopropyl Alcohol	180 pcs	67.00	67.00
Matches	500 ml	5.00	5. 00
Candle	1 pc	5.00	5.00
Iron chopstick	1 pc	2.00	2.00
Mosquito net	10 m	35.00	350
Insulator foam	10 m	65.00	650.00
78x 48 Blanket	3 pcs	120.00	360.00
Bamboo	6 pcs	10.00	60.00
2x2 coco lumber	6 pcs	110.00	660.00
Sprayer	2 pcs	20.00	40.00
1-inch hose	10 m	28.00	280.00
24 inches Iron rod	2 pcs	270.00	540.00
Flat angle bad iron	2 pcs	395.00	790.00
Welding machine	1 pc	200.00	200.00
Welding rod	3 kg	68.00	272.00
LPG gas	1 tank	765.00	765.00

3.7 Statistical Treatment of Data

The following procedures were used to interpret the data gathered based on the experiment of a comparative study on yields of oyster mushrooms using sterilized palay husk and carbonized palay husk as a fruiting bag. Each mixture proportion had thirty fruiting bags and had undergone the same treatment.

3.7.1. Simple percentage

To find the percentage level of the productivity of oyster mushrooms using different mixture proportions (100% SPH, 75% SPH- 25 LS, 50% SPH- 50% LS, 25% SPH- 75% LS and 100% CPH, 75% CPH- 25% LS, 50% CPH- 50% LS, 75% CPH- 25% LS) was by taken the average mean of the number of yields per piece, mass per grams, size and height in centimeter.

3.7.2. Weighted Mean

The statistical tool was used to calculate the average by multiplying the weight by its respective mean and taking its sum in terms of yield per piece, mass per gram, size, and height in centimeter based on the productivity of oyster mushrooms.

3.7.3. ANOVA TEST

This tool determined which substrate mixture proportion (100% SPH, 75% SPH- 25 LS, 50% SPH- 50% LS, 25% SPH- 75% LS and 100% CPH, 75% CPH- 25% LS, 50% CPH- 50% LS, 75% CPH- 25% LS) has a significant effect on the number of yields, mass, size, and height after using the SPH-LS and CPH-LS on different mixture proportion.

3.7.4. Two-Tailed Test

The statistical tool was used to test the significant effect on different mixture proportions, which resulted in a p-value less than 0.05 (100% SPH, 75% SPH- 25 LS, 50% SPH- 50% LS, 25% SPH- 75% LS and 100% CPH, 75% CPH- 25% LS, 50% CPH- 50% LS, 75% CPH- 25% LS) through taking the probability distribution of productivity in terms of number of yield per piece, mass per gram, size and height in centimeter

6. Presentation, Interpretation, and Analysis of Data

This chapter provides the statistical presentation relative to the problem posed in the problem statement. The corresponding analysis and interpretation of data in the production of oyster mushrooms using sterilized palay husk with lye straw and carbonized palay husk with lye straw as a fruiting bag in terms of yield, mass, size and height.

Table 9 shows the percentage level of mushroom productivity using a mixture of sterilized palay husk and lye straw at different proportions.

The productivity of the mushroom can be identified in the number of yields per piece, the mass per gram, size, and height in centimeters.

Table 9. Mushroom Productivity Using Mixture of Sterilized Palay Husk and Lye Straw at Different Proportions

Productivity	The proportion of Sterilized Palay Husk and Lye Straw			
	100% SPH	75% SPH:25% LS	50% SPH:50% LS	25% SPH:75% LS
Number of Yields (pc)	748	1096	1491	2843
Mass (grams)	710	935	1480	3395
Size (cm)	3.45	4.02	4.31	4.62
Height (cm)	3.29	3.63	4.13	3.85

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Among the proportion indicated in the table, the average of 25% SPH and 75% LS gain a greater number of yields which is 2843 pieces. The same with the mass, which measures 3395 grams. The size of the mushroom in this proportion is 4.62 cm. This means that from the ratio used in mushroom production, 25% SPH and 75% LS produces good production since it resulted in more yield and gain in height, mass, and size.

However, the height of the mushroom in cm is better in the proportion of 50% SPH and 50% LS since it produces 4.13 cm in height.

Based on the study conducted by Cyriacus et al. (2021), the yield and efficiency from sawdust were better than those cultivated on rice straw; however, the mushroom fruiting bodies were larger in straw size. Based on the study, seven different substrates made from 3 base substrates of cotton waste, wheat straw, and crushed baobab fruit shells were compared for their performance in oyster mushroom (Pleurotus ostreatus) cultivation for times of spawn development and harvesting as well as yield and quality. The yield of cultivated mushrooms and morphological features of their fruiting bodies differed ($p<0.05$) significantly as a result of the different physiochemical compositions of the growing substrate.

Substrates of lignocellulosic materials generally contain lower protein content and, as such, the production is inferior. In this study, treatments with wheat straw (Trt2) and baobab fruit shells (Trt3) obtained lower growth and yield of mushroom as compared to treatment Trt1 (cotton waste). Even when combinations of these substrates were done with cotton waste (Trt4, Trt5, and Trt7), their performance either did not significantly (>0.05) improve or was better than Trt1. However, when wheat straw alone (Trt2) was supplemented with cotton waste (Trt7), its performance improved significantly () for some characters recorded, such as S-CSR and S-PF. The above study results reveal that when substrates are known to have a high C : N augmented by N-rich material, the productivity was not altered for most of the parameters.

Likewise, in an investigation conducted by Zhang et al. (2001) to determine the effects of the rice straw and wheat straw on oyster mushrooms. The ground straw, as compared to chopped straw, yielded higher production and it was efficient. The growth of mushrooms on the ground straw is five days shorter than the chopped. However, it is found that there is a decrease in yield by using grounded straw as a substrate—Rice straw yields 10% more than wheat straw under the same variables in experimenting.

As indicated in Table 10 below, the percentage level of mushroom productivity using a mixture of CPH and LS at different proportions.

Table 10. Mushroom Productivity Using Mixture of Carbonized Palay Husk and Lye Straw at Different Proportion

Productivity	The proportion of carbonized palay husk with lye straw			
	100% CPH	75% CPH: 25% LS	50% CPH: 50% LS	25% CPH: 75% LS
Number of Yields (pc)	-	520	944	2323
Mass (grams)	-	495	885	2580
Size (cm)	-	3.94	4.02	5.12
Height (cm)	-	3.56	3.76	4.61

The productivity of the mushroom can be identified in the number of yields per piece, the mass per gram, size, and height in centimeters.

Among the proportion described in the table, 25% CPH and 75% LS gain a greater number of yields which is 2323 pieces. The mushroom size is 5.12 cm, and its height is 4.61 cm.

This means that among the proportion of CPH and LS, the combination of 25% SPH and 75% LS is better in producing mushrooms.

On the other hand, using 100% carbonized palay husk and lye straw does not produce growth in the mushroom. This means that carbon could be used as fertilizer for plants and as a substrate for mushrooms but cannot be used alone. Thus, carbon could mix with another substrate rich in cellulose to grow mushrooms.

This is why 100% of CPHs don't have any sprout of oyster mushroom. The carbonized palay husk is the right fertilizer for plant life and vegetation as soon as delivered to the soil. Carbonization of the substrate has been instructed to be a green approach to developing mushrooms. This is used to enhance the carbon composition of mushrooms and has additionally been used for soil productivity, carbon storage, and filtration of percolating soil water. Consequently, it's important to observe and confirm the result of using carbonized sawdust (CS) as a substrate for the increase and yield of Pleurotus ostreatus fruiting bodies.

In research performed by Ogbodo, the growth and yield parameters of 3 lines of Pleurotus eryngii, including Pe-1 (local to Bangladesh), Pe-2 (germplasm gathered from China), and Pe-3 (germplasm gathered from Japan) cultured on sawdust and rice straw for similar improvement withinside the availability of plant vitamins with rice hull charcoal application changed into doing.

Table 11 below shows the significant effect of different mixture proportions of SPH-LS on mushroom productivity. A mixture of SPH-LS has a significant effect on the productivity of mushrooms. As seen in the average number of yields, mass, and size. The combination of 100% SPH, 75% SPH - 25%LS, 50% PH - 50% LS, and 75% SPH – 25% LS. The computed (F=9.98) average number of yields, (F=14.84) mass in gram, and (F=7.21) size in centimeter with the (P=0.000), respectively. This means that the said mixture combination is effective for mushroom production. However no significant effect in the height of the mushroom in different mixture proportions with (P=0.015).

Table 11. Effect of Different Mixture Proportion of Sterilized Palay Husk and Lye Straw on Mushroom Productivity

Productivity	SPH - LS				F	P	Sig.
	100%	75%-25%	50%-50%	25%-75%			
Ave. Number of Yields	68.0b	78.3b	93.2b	157.9a	9.98	0.000	Sig
Mass (grams)	64.5b	66.8b	92.5b	188.6a	14.84	0.000	Sig
Size (cm)	3.50b	4.02b	4.31b	5.39a	7.21	0.000	Sig
Height (cm)	3.36c	3.63bc	4.13ab	4.49a	3.92	0.013	Sig

Means that do not share a letter are significantly different.

The sterilization process needs a constant temperature of around 112 °C-142 °C. Contamination may occur in the form of other unwanted fungi (pests) if the sterilization temperature does not reach the desired temperature. However, if the temperature is too high, it may damage the nutrients needed for growing mushrooms (Abdurrahman, 2019).

For the improvement of mushroom production and its yield, the mushroom growers use different sterilization techniques. Three different types of sterilization methods, viz chemical sterilization (formaldehyde + carbendazim), steam sterilization, and hot-water sterilization, were evaluated for the growth parameters and productivity of oyster mushrooms cultivated on rice straw. (Khan et al. 2011). The researcher used steam sterilization to prevent contamination by harmful microorganisms that may hamper mushroom growth. The sterilization lasted for eight hours before boiling water to disinfect the substrates of the mushrooms to kill microorganisms that may hamper the yield of oyster mushrooms. Based on the study of Khan et al. (2011), the sterilization of substrates is a much more appropriate method for effective and smooth cultivation of mushrooms to remove the existence of several microorganisms.

Table 12 below shows the significant effect of different mixture proportions of CPH-LS in mushroom productivity aside from 100% CPH.

Table 12. Effect of Different Mixture Proportion of Carbonized Palay Husk and Lye Straw on Mushroom Productivity

Productivity	CPH and LS Mixture				F	P	Sig.
	100%	75%-25%	50%-50%	25%-75%			
Ave. Number of Yields	-	43.33b	67.43b	154.9a	13.91	0.000	Sig
Mass (grams)	-	41.25b	63.21b	172.0a	14.43	0.000	Sig
Size (cm)	-	3.94b	4.02b	5.12a	13.70	0.000	Sig
Height (cm)	-	3.56b	3.76b	4.61a	11.64	0.000	Sig

Means that do not share a letter are significantly different.

The main purpose of mushroom cultivation is yield. The current study reveals that the yield was influenced differently by the different substrate treatments used in cultivation. The differences in the yield also impacted the biological efficiency of the substrate treatments. In general, higher yield substrates also give a higher BE value (Muswati, 2021). In this study, the mixture of CPH-LS affects the mushroom's productivity as seen in the average number of yields, mass, size, and height from the combination of 75% CPH - 25% LS and CPH 25% SPH - 75% LS. The (f=13.91) average number of yields, (f=14.43) mass in grams, (f=13.70) size in cm and (11.64) height in cm with the (P=0.000). This means that the three-mixture proportion is effective for mushroom production.

The choice of the substrate in mushroom production is important since it significantly influences the productivity of oyster mushrooms for better growth, development, and yield. Unfortunately, substrates of lignocellulosic materials in origin generally contain lower protein content, and, as such, the production is inferior (Muswati, 2021).

Table 13 below shows the significant difference in mushroom productivity between the SPH-LS and CPH-LS using the different mixtures regarding the number of yields per piece. The SPH-LS (75%– 25%) has shown significantly different from CPH-LS (75% – 25%) and CPH-LS (25% – 75%) but not significantly different from CPH-LS (50% – 50%). Here, it is recommended to use the SPH-LS: 75% – 25% (M = 78.3) than CPH-LS: 75% – 25% (M = 43.3). However, the CPH-LS: 25% – 75% (M = 154.9) is highly recommended than SPH-LS: 75% – 25% (M = 78.3)

Table 13. Significant Difference in Mushroom Productivity between SPH-LS and CPH-LS Using Different Mixture Proportion as to Yield (Number/Pc)

Sterilized Palay Husk and Lye Straw	Carbonized Palay Husk and Lye Straw			
	100% CPH (none)	75% – 25% (M = 43.3 pcs)	50% – 50% (M = 67.4 pcs)	25% – 75% (M = 154.9 pcs)
100% SPH	5.71	1.99	0.042	-3.23
(M = 68.0 pcs)	0.000**	0.069ns	0.967ns	0.004**
75% – 25%	6.25	2.69	0.766	-2.82
(M = 78.3 pcs)	0.000**	0.017*	0.453 ns	0.012*
50% – 50%	8.89	4.52	2.08	-2.35
(M = 93.2 pcs)	0.000**	0.000**	0.048*	0.029*
25% – 75%	-10.20	5.37	5.37	0.107
(M = 157.9 pcs)	0.000**	0.000**	0.000**	0.915 ns

**Significant at 0.01 level two-tailed test *Significant at 0.05 level two-tailed test ns-not significant

The SPH-LS (50% – 50%) shows significant difference with CPH-LS (75% – 25%), CPH-LS (50% – 50%), and CPH-LS (25% – 75%). Therefore, it is recommended to use CPH-LS: 25% – 75% (M = 154.9). Others are equally recommended.

SPH-LS (25% – 75%) is not significantly different (p > 0.05) with CPH-LS (25% – 75%) as both have almost the same average yield produced. However, compared with the other two CPH-LS, SPH-LS is more recommended.

Based on the study, the growth and yield of mushrooms were influenced differently by the different substrates used in cultivation. The impact on the biological efficiency of the substrate also affects the mushroom yield. (Serrano, 2021).

According to Muswati el., at (2021), the choice of the substrate in mushroom production is important since it significantly influences oyster mushrooms' productivity for better growth, development, and yield. Substrates of lignocellulosic materials in origin generally contain lower protein content and, as such, the production is inferior. Based on the investigation, utilized treatments with wheat straw (Trt2) and baobab fruit shells (Trt3) obtained lower growth and yield of mushrooms as compared to treatment Trt1 (cotton waste). Even when combinations of these substrates were done with cotton waste (Trt4, Trt5, and Trt7), their performance either did not significantly (p>0.05) improve or was better than Trt1. However, when wheat straw alone (Trt2) was supplemented with cotton waste (Trt7), its performance improved significantly (p<0.05) for some characters recorded, such as S-CSR and S-PF. The above study results reveal that when substrates are known to have a high C : N augmented by N-rich material, the productivity was not altered for most of the parameters. Consequently, while it is an important strategy for promoting the utilization of locally available agro-industrial by-products in mushroom farming, augmentation of the raw substrate can produce negative effects. This could be attributed to the change in the substrate composition, such as pH, temperature, moisture, aeration, and amount and activity of microbes, which affect mushroom productivity.

Table 14 below shows significant differences in mushroom productivity, but the use of SPH-LS and CPH-LS using the different mixtures on the mass per gram.

Table 14. Significant Difference in Mushroom Productivity between SPH-LS and CPH-LS Using Different Mixture Proportion as to Mass (grams).

Sterilized Palay Husk and Lye Straw	Carbonized Palay Husk and Lye Straw 100% CPH (none)	75%– 25% (M = 41.2 gm)	50% – 50% (M = 63.2 gm)	25% – 75% (M = 172.0)
100% SPH (M = 64.5 gm)	5.89 0.000**	1.90 0.076ns	0.103 0.919ns	-3.53 0.002**
75% – 25% (M = 66.8 gm)	7.57 0.000**	2.46 0.022*	0.321 0.751ns	-3.54 0.003**
50% – 50% (M = 92.5 gm)	7.84 0.000**	3.94 0.000**	2.15 0.042*	-2.59 0.018*
25% – 75% (M = 188.6 gm)	8.17 0.000**	6.18 0.000**	5.16 0.000**	0.374 0.711ns

**Significant at 0.01 level two-tailed test *Significant at 0.05 level two-tailed test ns-not significant

The result shows a significant difference in the mass-produced between SPH-LS and CPH-LS at different proportional mixtures. Between SPH-LS (100%) and CPH-LS (75% – 25%) as well as with CPH-LS (50%–50%), there is no significant difference in the mass-produced. This is manifested by a P > 0.05 level. However, between SPH-LS (100%) and CPH-LS (25%– 75%), a significant difference is seen as revealed by the probability value of 0.002, which is greater than 0.01 (p < 0.01). Comparing which one is best to use, the 25 % CPH with 75% LS (M = 172.0) is recommended than SPH-LS: 100% (M = 64.5).

SPH-LS (75% – 25%) is significantly different from CPH-LS (75% – 25%) and CPH-LS (25% – 75%) but not significantly different from CPH-LS (50% – 50%). Here, it is recommended to use the SPH-LS: 75% – 25% (M = 66.8) than CPH-LS: 75% – 25% (M = 41.2). However, the CPH-LS: 25% – 75% (M = 172.0) is highly recommended than SPH-LS: 75% – 25% (M = 66.8). A non-significant difference shows the same effect and is equally recommended.

The SPH-LS (50% – 50%) shows significant difference with CPH-LS (75% – 25%), CPH-LS (50% – 50%), and CPH-LS (25% – 75%). Here, it is recommended to use CPH-LS: 25% – 75% (M = 172.0). Others are equally recommended.

SPH-LS (25% – 75%) is not significantly different (p > 0.05) from CPL-LS (25% – 75%) as both have almost the same average mass-produced. However, compared with the other two CPH-LS, SPH-LS is more recommended.

The mushroom weight (grams) of oyster mushroom depended on the length and thickness of the stipe, cap diameter, number of yields, and the thickness of the cap. (Thi Hoa, e.l at. 2015)

Table 15 below shows if there is a significant difference in mushroom productivity, but the use of SPH-LS and CPH-LS using the different mixtures as to the size of mushroom in centimeters.

Table 15 Significant Difference in Mushroom Productivity between SPH-LS and CPH-LS Using Different Mixture Proportion as to Size (cm).

Sterilized Palay	Carbonized Palay Husk and Lye Straw			
Husk and Lye Straw	100% CPH (none)	75% – 25% (M = 3.94 cm)	50%– 50% (M = 4.02 cm)	25% – 75% (M = 5.12 cm)
100% SPH	11.6	-1.18	-1.523	-4.64
(M = 3.5 cm)	0.000**	0.252ns	0.147ns	0.000**
75% – 25%	18.1	0.256	0.000	-3.902
(M = 4.02 cm)	0.000**	0.800ns	1.00ns	0.000**
50% – 50%	18.36	1.138	1.009	-2.792
(M 4.31 cm)	0.000**	0.266ns	0.322ns	0.009**
25% – 75%	14.72	3.407	3.444954	0.677
(M = 5.39 cm)	0.000**	0.002**	0.002**	0.505ns

**Significant at 0.01 level two-tailed test *Significant at 0.05 level two-tailed test ns-not significant

Between SPH-LS (100%) and CPH-LS (75% – 25%) as well as with CPH-LS (50%– 50%), there is no significant difference in the size produced. This is manifested by a P > 0.05 level. However, between SPH-LS (100%) and CPH-LS (25%– 75%), a significant difference is seen as revealed by the probability value of 0.002, which is greater than 0.01 (p < 0.01). Comparing which one is best to use, the 25 % CPH with 75% LS (M = 5.39) is recommended than SPH-LS: 100% (M = 3.5).

SPH-LS (75% – 25%) is significantly different from CPH-LS (75% – 25%) and CPH-LS (25% – 75%) but not significantly different from CPH-LS (50% – 50%). Here, it is recommended to use the SPH-LS: 75% – 25% (M = 4.02) than CPH-LS: 75% – 25% (M = 3,94). However, the CPH-LS: 25% – 75% (M = 5.39) is highly recommended than SPH-LS: 75% – 25% (M = 3.94). A non-significant difference shows the same effect and equally recommended.

The SPH-LS (50% – 50%) shows significant difference with CPH-LS (75% – 25%), CPH-LS (50% – 50%), and CPH-LS (25% – 75%). Here, it is recommended to use CPH-LS: 25% – 75% (M = 5.12). Others are equally recommended.

SPH-LS (25% – 75%) is not significantly different (p > 0.05) from CPH-LS (25% – 75%) as both have almost the same average size produced. Compared with the other two CPH-LSs, SPH-LS is more recommended.

Several other authors, Besufekad et al., Chukwurah et al., Tsegaye and Tefera, Onyeka et al., and Dubey et al., also observed the significance of using different substrates used in mushrooms. For example, the size of the mushroom is dependent on substrates that are poor in cellulose, hemicelluloses, and lignin which constitute physical barriers and are difficult to be broken down without the presence of the lignin-degrading enzyme.

Table 16 below shows a significant difference in mushroom productivity, but the use of SPH-LS and CPH-LS using different mixtures as to the size of mushroom in height.

Table 16. Significant Difference in Mushroom Productivity between SPH-LS and CPH-LS Using Different Mixture Proportion as to Height (cm).

Sterilized Palay Husk and Lye Straw	Carbonized Palay Husk and Lye Straw 100% CPH (none)	75% – 25% (M = 3.56 cm)	50% – 50% (M = 3.76 cm)	25% – 75% (M = 4.61 cm)
100% SPH	11.74	-0.585	-1.301	-3.799
(M = 3.36 cm)	0.000**	0.566ns	0.214ns	0.002**
75% – 25%	17.72	0.246	-0.557	-3.73
(M = 3.63 cm)	0.000**	0.808ns	0.583ns	0.001**
50% – 50%	18.43	1.91	1.410	-1.71
(M = 4.13 cm)	0.000**	0.067ns	0.171ns	0.098ns
25% – 75%	16.20	2.740	2.375	-0.348
(M = 4.49 cm)	0.000**	0.011*	0.0259*	0.730ns

**Significant at 0.01 level two-tailed test *Significant at 0.05 level two-tailed test Ns - not significant

Between SPH-LS (100%) and CPH-LS (75% – 25%) as well as with CPH-LS (50%– 50%), there is no significant difference in the height produced. This is manifested by a P > 0.05 level. However, between SPH-LS (100%) and CPH-LS (25%– 75%), a significant difference is seen as revealed by the probability value of 0.002, which is greater than 0.01 (p < 0.01). Comparing which one is best to use, the 25 % CPH with 75% LS (M = 4.61) is recommended than SPH-LS: 100% (M = 3.36).

SPH-LS (75% – 25%) is significantly different from CPH-LS (75% – 25%) and CPH-LS (25% – 75%) but not significantly different from CPH-LS (50% – 50%). Here, it is recommended to use the SPH-LS: 75% – 25% (M = 3.63) than CPH-LS: 75% – 25% (M = 3.56). However, the CPH-LS: 25% – 75% (M = 4.61) is highly recommended than SPH-LS: 75% – 25% (M = 3.63). A non-significant difference shows the same effect and is equally recommended.

The SPH-LS (50% – 50%) shows significant difference with CPH-LS (75% – 25%), CPH-LS (50% – 50%), and CPH-LS (25% – 75%). Here, it is recommended to use CPH-LS: 25% – 75% (M = 4.61). Others are equally recommended.

SPH-LS (25% – 75%) is not significantly different (p > 0.05) from CPH-LS (25% – 75%) as both have almost the same average height produced. However, compared with the other two CPH-LSs, SPH-LS is more recommended.

According to the studies of Thi Hoa (2015), the Pleurotus species needed carbon, nitrogen, and inorganic compounds as their nutritional sources. The main nutrients are less nitrogen and more carbon, so materials containing cellulose, hemicellulose, and lignin (i.e., rice and wheat straw, cotton seed hulls, sawdust [SD], wastepaper, leaves, and sugarcane residue) can be used as mushroom substrates. Oyster mushrooms can grow on a wide variety of substrates. However, the yield and the quality of oyster mushrooms depend on the chemical and nutritional content of substrates.

7. Summary, Conclusions, And Recommendations

This chapter presents the summary, findings, conclusions, and recommendations.

5.1 Summary

The comparative study on yields of oyster mushrooms using SPH-LS and CPH-LS in different proportions as fruiting bags in terms of the number of yields (piece), mass (gram), size, and height (cm) revealed that these are influenced by the treatment and substrate being used.

The experimental research design was utilized in testing and proving the research hypothesis. This was done through direct observation of the researcher on fruiting bags as indicated by the number of yields, mass, size, height, texture, and appearance for one month under the same treatment.

Based on the data gathered on the fruiting bags, the results were interpreted using statistical tools such as Simple Percentage, Weighted Mean, ANOVA Test, and Two-Tailed Test. Based on the presentation and analysis of the data, the following findings were obtained:

The results indicated on SPH-LS in different proportion reveals that the average of 25% SPH and 75% LS gain a greater number of yields which is 2843 pieces. The same with the mass, which measures 3395 grams. The size of the mushroom in this proportion is 4.62 cm.

This means that the proportion of 25% SPH and 75% LS is recommended since it produces a greater yield (piece), mass (grams), and size(cm). However, the height of the mushroom in cm is better in the proportion of 50% SPH and 50% LS since it produces 4.13 cm.

The productivity of oyster mushrooms can be identified in the number of yields (piece), mass (gram), size, and height (cm) using CPH-LS in different proportions. It reveals that the 25% CPH and 75% LS gain more yield, 2323 pieces. The mushroom size is 5.12 cm, and its height is 4.61 cm. This means that among the proportion of CPH and LS, the combination of 25% SPH and 75% LS is better in producing mushrooms.

There is a significant effect in different mixture proportions of SPH-LS on mushroom productivity. The computed (F=9.98) average number of yields, (F=14.84) mass in gram, and (F=7.21) size in centimeter with the (P=0.000), respectively. This means that the said mixture combination is effective for mushroom production. However no significant effect in the height of the mushroom in different mixture proportions with (P=0.015).

The significant effect in different mixture proportions of CPH-LS in mushroom productivity aside from 100% CPH. The combination of 75% CPH - 25% LS and SPH 25% SPH - 75% LS. The (f=13.91) average number of yields, (f=14.43) mass in grams, (f=13.70) size in cm and (11.64) height in cm with the (P=0.000). This means that the three-mixture proportion is effective for mushroom production.

It is recommended to use the SPH-LS: 75% – 25% (M = 78.3) than CPH-LS: 75% – 25% (M = 43.3) since there is a significant difference in mushroom productivity between the SPH-LS and CPH-LS using the different mixture in terms of the number of yields (piece).

However, there is a significant difference in the mass-produced between SPH-LS and CPH-LS at different proportional mixtures. Between SPH-LS (100%) and CPH-LS (75% – 25%) as well as with CPH-LS (50%–50%), there is no significant difference in the mass-produced. This is manifested by a P > 0.05 level. However, between SPH-LS (100%) and CPH-LS (25%– 75%), a significant difference is seen as revealed by the probability value of 0.002, which is greater than 0.01 (p < 0.01). Comparing which one is best to use, the 25 % CPH with 75% LS (M = 172.0) is recommended than SPH-LS: 100% (M = 64.5). SPH-LS (75% – 25%) is significantly different with CPH-LS (75% – 25%) and CPH-LS (25% – 75%) but not significantly different with CPH-LS (50% – 50%). Therefore, it is recommended to use the SPH-LS: 75% – 25% (M = 66.8) than CPH-LS: 75% – 25% (M = 41.2). However, the CPH-LS: 25% – 75% (M = 172.0) is highly recommended than SPH-LS: 75% – 25% (M = 66.8). A non-significant difference shows the same effect and is equally recommended. The SPH-LS (50% – 50%) shows significant difference with CPH-LS (75% – 25%), CPH-LS (50% – 50%), and CPH-LS (25% – 75%). Likewise, it is recommended to use CPH-LS: 25% – 75% (M = 172.0). Others are equally recommended. SPH-LS (25% – 75%) is not significantly different (p > 0.05) from

CPL-LS (25% – 75%) as both have almost the same average mass-produced. Compared with the other two CPH-LS, SPH-LS is more recommended.

There is a significant difference in mushroom productivity, but SPH-LS and CPH-LS use different mixtures as to the mushroom size in centimeters. Between SPH-LS (100%) and CPH-LS (75% – 25%) as well as with CPH-LS (50%– 50%), there is no significant difference in the size produced. This is manifested by a P > 0.05 level. However, between SPH-LS (100%) and CPH-LS (25%– 75%), a significant difference is seen as revealed by the probability value of 0.002, which is greater than 0.01 ($p < 0.01$). Comparing which one is best to use, the 25 % CPH with 75% LS (M = 5.39) is recommended than SPH-LS: 100% (M = 3.5). SPH-LS (75% – 25%) is significantly different from CPH-LS (75% – 25%) and CPH-LS (25% – 75%) but not significantly different from CPH-LS (50% – 50%). Therefore, it is recommended to use the SPH-LS: 75% – 25% (M = 4.02) than CPH-LS: 75% – 25% (M = 3,94). However, the CPH-LS: 25% – 75% (M = 5.39) is highly recommended than SPH-LS: 75% – 25% (M = 3.94). A non-significant difference shows the same effect and is equally recommended.

The SPH-LS (50% – 50%) shows significant difference with CPH-LS (75% – 25%), CPH-LS (50% – 50%), and CPH-LS (25% – 75%). Hence, it is recommended to use CPH-LS: 25% – 75% (M = 5.12). Others are equally recommended.

SPH-LS (25% – 75%) is not significantly different ($p > 0.05$) from CPH-LS (25% – 75%) as both have almost the same average size produced. Compared with the other two CPH-LSs, SPH-LS is more recommended.

Between SPH-LS (100%) and CPH-LS (75% – 25%) as well as with CPH-LS (50%– 50%), there is no significant difference in the height produced. This is manifested by a P > 0.05 level. However, between SPH-LS (100%) and CPH-LS (25%– 75%), a significant difference is seen as revealed by the probability value of 0.002, which is greater than 0.01 ($p < 0.01$). Comparing which one is best to use, the 25 % CPH with 75% LS (M = 4.61) is recommended than SPH-LS: 100% (M = 3.36).

SPH-LS (75% – 25%) is significantly different from CPH-LS (75% – 25%) and CPH-LS (25% – 75%) but not significantly different from CPH-LS (50% – 50%). Therefore, it is recommended to use the SPH-LS: 75% – 25% (M = 3.63) than CPH-LS: 75% – 25% (M = 3.56). However, the CPH-LS: 25% – 75% (M = 4.61) is highly recommended than SPH-LS: 75% – 25% (M = 3.63). A non-significant difference shows the same effect and is equally recommended.

The SPH-LS (50% – 50%) shows significant difference with CPH-LS (75% – 25%), CPH-LS (50% – 50%), and CPH-LS (25% – 75%). It is recommended to use CPH-LS: 25% – 75% (M = 4.61). Others are equally recommended.

SPH-LS (25% – 75%) is not significantly different ($p > 0.05$) from CPH-LS (25% – 75%) as both have almost the same average height produced. However, compared with the other two CPH-LSs, SPH-LS is more recommended.

5.2 Conclusion

There is a significant effect on different mixture proportions of sterilized palay husk with lye straw in mushroom productivity in terms of yield (piece), mass (gram) size (cm), respectively. This means that the said mixture proportion is effective for mushroom production. However, there is no significant effect on the height (cm) of the mushroom. Thus, the null hypothesis is rejected using SPH-LS in terms of the number of yield, mass, and size but partially rejected in terms of height.

There is a significant effect on different mixture proportions of carbonized palay husk with lye straw in mushroom productivity in terms of yield (piece), mass (gram), size, and height (cm), respectively. This means that the said mixture proportion is effective for mushroom production. Thus, the null hypothesis is rejected on using CPH-LS in terms of the number of yield (piece), mass (gram), size, and height (cm).

However, there is a significant difference between the sterilized palay husk and carbonized palay husk as the fruiting bag. It revealed that the sterilized palay husk with lye straw produced a greater amount of oyster mushroom in yield (piece), mass (gram), and size (cm) but had no significant difference in terms of height.

5.3 Recommendation

After thoroughly analyzing and interpreting the data, the following recommendations were formulated.

- Disseminate the utilization of the efficiency of agro-wastes as the substrate for mushroom specially sterilized palay hush with lye straw. Sterilization technique as an oyster mushroom substrate is essential to prevent harmful microorganisms that may contaminate and hamper mushroom growth. This study also determined the efficiency of 25% of sterilized palay husk with 75% of lye straw in terms of yield, mass, size, and height of oyster mushroom.
- Inform the mushroom growers that carbonized palay husk with lye straw could also be used as the substrate of mushroom but not as efficient as sterilized palay husk with lye straw in mushroom productivity of number of yield, mass, size and height.
- The future researcher should lengthen the observation period on the productivity of mushrooms since the fruiting bags could last for four to six months.
- The future researcher is encouraged to use different organic substrates or other agricultural wastes and conduct a study on ideal substrates to be used aside from this current study.
- The future researcher is encouraged to conduct a survey on mushroom growers in nearby communities for further substantial techniques, and another substrate may use to increase the productivity of oyster mushrooms.

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