INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 24, No. 4, p. 30-35, 2024
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Yield performance of Brown Oyster Mushroom (*Pleurotus cystidiosus*) using different liming materials

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Article published on April 06, 2024

Key words: Brown oyster mushroom, Filter cake, Rice hull ash, Agricultural lime, Wood ash

Abstract

Mushroom industry is still burgeoning in the Philippines and has high demand both in local and world markets. However, there are yet to be studied on the matter of cultivation substrates which production is at stake. To cultivate mushrooms, the raw materials mainly are agricultural by-products which, at times are unavailable in certain areas particularly the liming material needed. Different by-products were evaluated as potential alternative liming material for brown oyster mushroom (*Pleurotus ostreatus*) cultivation in fruiting bags. The Complete Random Design (CRD) was used to lay out the experiment with five treatments (T1–no liming material, T2 - with filter cake), T3 - with rice hull ash), T4 - with agricultural lime), and T5 - with wood ash). These potential liming materials assessed on their influence on mycelia growth, yield, number of stipes (stem), and pileus (cap) diameter. The research revealed significant differences in mycelia growth, pileus (cap) diameter and yield and found no significance on the number of stipes (stem). Significant difference was observed in mycelia growth from Treatment 2 when compared to T1, T3, T4, and T5 respectively. The treatment using agricultural lime (T4) yield was found highly significant to T3, T2, T5 and T1 with a mean yield of 1,307.00 g, 1,291.00 g, 1,037.10 g and 770.04 g respectively. Moreover, T3, T2, T5 are not par with each other. Analysis of variance on pileus (cap) diameter showed significant differences among Treatment means where T4 is significantly different with T2, T3, and T5 but showed no significance on T3, T4, and T5. For the number of stipes (stem), the experiment revealed no significance among treatment means. Of and among the treatments, the treatment using agricultural lime still performs best as the package of technology on oyster mushroom cultivation standardized it so. Nevertheless, this research output claims the utilization of the liming material alternatives especially when the agricultural lime is unavailable.

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Introduction

Earthy, tasty and healthy mushrooms have been eating for thousands of years and have driven vitamin rich mushrooms and topped to different menus. With the advent of the Organic Agriculture Act also known as RA 10068, mushroom, a genuinely grown free from fertilizer and pesticides, Filipino has learned to cultivate over the years. Mushroom industry is still burgeoning in the Philippines and has high demand in both domestic and world market.

The Brown oyster mushroom (*Pleurotus cystidiosus*) is just one of the about 1,400 mushroom species that is being introduced in the Philippines to culture. Recently, production is site specific, which growers are to look into alternatives such as fruiting bag or log substrates, grain substrates, as well as liming materials or agents. One such problematic in availability is the liming material because it is being used in building construction, various processing planta, and more on several agricultural activities like fish growing in ponds, applying agricultural to acidic soils, and the like. It is vital to learn the alternatives such that wherever part of the country, availability of materials would not be a hindrance among Filipinos to grow mushrooms.

To produce abundant mushroom, according to Khan *et al.* (2013) as cited by Martinez *et al.* (2019), potential Hydrogen (pH) is a pertinent factor for $CaCO_3$ is an important constituent in mushroom cultivation. There are several possible liming agents to be used in various mushroom species grown in fruiting bags namely, filter cake, wood ash, and rice hull ash. Nevertheless, agricultural lime is still being used.

Filter cake is one of the wastes from the sugar industry after processes like extraction, clarification and filtration. One of the sugar plants in the Philippines is located in Piat, Cagayan. Filter cake is therefore abundant and of free to collect. Wood ash is also readily available among households because Filipinos are fond of using wood to cook food; just make sure that plastic wastes are not being burned together with the wood. Rice hull ashes (RHA) are combusted rice hulls. Cagayan is known as a producer of rice, so rice hulls are available everywhere.

This study aims to determine liming material/s that will provide the fastest mycelia growth. This indicator manifests the ability of the potential hydrogen to put the oyster mushroom substrates in neutral condition thereby allowing mycelia growth to ramify and proliferate persistently. It also aims to determine good oyster mushroom yield which results would emanate from the inputs in the cultivation.

The results of this study will be utilized by several mushroom growers in various communities which will provide information on the alternative liming agents to be used for neutralization of sawdust substrates for oyster mushroom production. It will also contribute to the existing literature on the management of growing oyster mushroom.

Materials and methods

Acquisition of materials

Consumables like 6x12 PP bag (Polypropylene bag), cotton, rubber band, used bond paper, tissue paper, denatured alcohol, and ethyl alcohol were purchased from various stores. Sawdust was purchased from a lumber company (regardless of what types of wood were processed). Planting spawn (grain spawn) of the brown oyster mushroom was purchased from a credible mushroom grower.

Fruiting bag preparation

For every treatment, 32.5 kg sawdust, 12.5 kg rice bran, 0.5 kg brown sugar, and 0.5 kg liming material. The above components were thoroughly mixed using a shovel, and then poured with tap water to attain 80% moisture content. The mixture was let undergo pre-decomposition for 3 days. After which, the mixture was bagged and weighed 750 grams per bag. The bags were sterilized using steel drums for 6 hours. The bags were then cooled and inoculated with grain spawns. Inoculated the bags for 30 days (Fig. 1).

Fig. 1. Step-by-step procedure in cultivating brown oyster mushroom

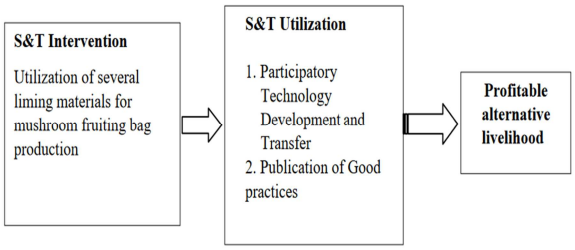

Fig. 2. Framework of the Study

Experimental design and treatments

The experiment was laid out into Completely Randomized Design (CRD) with five treatments replicated three times confined in the mushroom house. Experimental treatments were T1 (Control-No liming material), T2 (with Filter Cake), T3 (with Rice Hull Ash), T4 (with Agricultural Lime), and T5 (with Wood Ash). Framework of the study is shown in Fig. 2.

Results and Discussion

Mycelia growth

Treatment 4, 5, 1 and 3 ramified rapidly at its week 2 in terms of length, these results showed that sawdust cellulose, which is required by oyster mushroom for growth (Fig. 3). Observation during 1 to 2 weeks indicates that substrates applied with different liming material contains low nutrients that caused rapid growth of hyphae. But on its succeeding week, the hyphae grow more branches which causes slow growth in terms of length. While treatment 2 ramified slowly in terms of length during its first week but rapidly ramified at its 3rd to 4th week in terms of length. Filter cake is rich in nutrients than agricultural lime, it was reported that filter cake and sugar-cane stem waste consist of high lignocellulose and can be used for fungal growth, it was also reported a significant result with respect to mycelial growth, pinhead, fruiting body and harvest period for the medium of filter cake (Madriana, *et al.*, 2021), rice hull ash and wood ash which causes ramified more branches during first week and grow slowly. The more ramified branches grow faster at its later phase. This could be attributed to the physical nature, high porosity and how aerated the rice husk are causing the mushroom mycelia to run through the substrate (Manzo, 2011) while wood ash contains a significant amount of calcium, the primary substitute for lime to increase the pH it was also noted that wood ash is a natural substitute for lime to help maintain proper soil pH. Lime is used in cultivation of mushroom to enhance the pH of substrate. Rapid mycelia growth of mushroom like *Pleurotus sajor-caju* takes place at pH 6.4-7.8 This indicates that lime modifies the acidity of the medium and raised the heat of the bag. This confirms the validity with khan as the lime leads to a high acidity of the middle and thus reduces the speed of emergence of the threads of mycelium (Khan, *et al.*, 2013).

The mycelium of mushroom, like other fungal cells, lacks chlorophyll and consequently is unable to utilize carbon dioxide, mineral ions, and water for photosynthesis as do green plants. Nutritionally, mushrooms are heterotrophs and obtain their nutrients by absorbing soluble inorganic and organic materials from substrates as referred to this as absorptive or osmotrophic nutrition and the role of extracellular enzymes in breaking down insoluble compounds such as polysaccharides into smaller, soluble substances. Once organic compounds have entered the fungal cell, they can be converted to the various sugars, polysaccharides, proteins, lipids, purines, pyrimidines, vitamins, and among others which are required for vital activities and structural needs of the fungus.

The fungi are endeavored with exceptional metabolic capabilities; many of them are able to grow and reproduce when supplied with sugar as carbon source, nitrogen source, various minerals, vitamins and water. The carbon source provides the skeletal carbon for organic compounds and the energy for anabolic processes. The nitrogen is essential for amino acids and therefore, for proteins and enzymes. The mycelium excretes enzymes into the substrates and these enzymes degrade the insoluble compounds into soluble ones; then the mycelium absorbs these degraded and soluble molecules and uses them as nutrients for growth (Chang and Miles 2004).

Analysis of variance shows that there were significant differences among Treatment means in terms of mycelial growth during 2 weeks after inoculation. On the 4th week of inoculation, significant difference was observed from Treatment 2 when compared to T1, T3, T4, and T5 respectively. Hence, different liming materials has its peak of nutrient distribution at the first phase of decomposition of the substrate which degrade while the fruiting bags become older, this is contrary to Filter cake which nutrient absorption is more active during late phase of decomposition when compared to other treatments.

Yield (grams)

Among the different liming materials used as requirements for the cultivation of brown oyster mushroom (*Pleurotus cystidiosus*) the standard material (T4) supported the best yield of fungus as shown in Fig. 4. It was observed in the study that the density of mycelium at 2nd week it was needle like till it become thick and dense while spreading downward on the substrate. It was noted that yield of mushroom is directly related to the spread of mycelium into the fruiting bags, given that rice straw is suited for mycelial growth, present study were not able to utilize the substrate and thus not correspond with the yield using different liming materials, however, using these different liming materials will give basket of option when the standard liming material is not available in the locality, this is also indicate that the mycelial growth and yield of mushroom have different requirements like calcium and other essential elements.

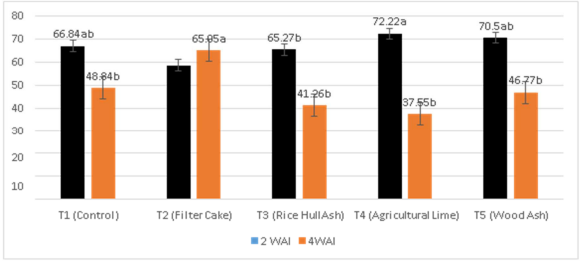

Fig. 3. Mean mycelia growth (mm) at 2 and 4 weeks after inoculation of brown oyster mushroom (*Pleurotus cystidiosus*) using different liming materials

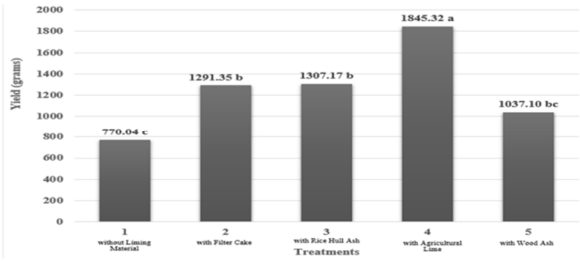

Fig. 4. Brown oyster mushroom (*Pleurotus cystidiosus*) mean yield (grams) using different liming materials

Analysis of variance shows significant differences among the Treatments means using different liming materials. Standard liming material (T4) is highly significant to T3, T2, T5 and T1 with a mean yield of 1307g, 1291g, 1037.1g and 770.04g respectively, moreover T3, T2, T5 are not par with each other, hence, this can be drawn that these liming materials have potential as source of calcium as alternative to agricultural lime. Given the potential of Filter Cake and Rice Hull Ash, present study noted that these can be used as alternative especially Filter cake has been considered as waste materials, including Rice Hull ash. It was recorded that Filter cake consists of crude protein, sugar, cellulose, chlorine, phosphate and fibre, the presence of cellulose, hemicellulose and lignin in culture medium promotes mycelial growth, which increases fruiting body formation (Mardiana, 2021).

Table 1. Mean number of stipes (stem) of brown oyster mushroom using different liming materials

Treatment	Mean (number)
1 – without Liming Material	2.77
2 – with Filter Cake	3.36
3 – with Rice Hull Ash	3.55
4 – with Agricultural Lime	3.06
5 – with Wood Ash	3.28

Number of stipes (stem)

The mean number of stipes (stem) (Table 1) among treatments is not significant with each other. This manifests that use of any of the different liming materials will provide comparable number of stipes (stem). The stipes (stem) of brown oyster mushroom is evident anyway on the number and is very distinct to its morphological features. Such observations were coincided with Chang and Miles (2004) that the *P. cystidiosus* O.K. Miller (brown mushroom) and *P. sajor-caju* (Fries) Sing. (gray oyster mushroom or phoenix-tail mushroom) are alike in terms of number of stipes (stem); they only differ slightly in pileus (cap) color. Unlike *P. ostreatus* var. *florida* nom. prov. Eger (white oyster mushroom), *P. citrinopileatus* Sing. (golden oyster-mushroom), *P. flabellatus* (Berk. and Br.) Sacc (pink oyster mushroom), and *P. sapidus* (Schulzer) Kalchbremer (black oyster mushroom) have very different stipes (stem) formation–clumped type of formation.

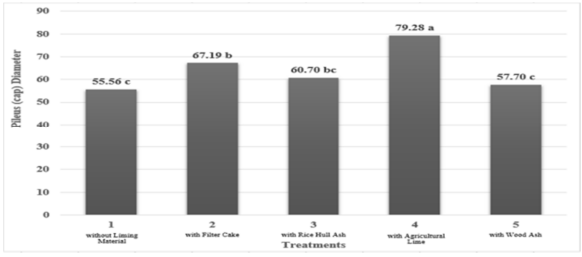

Fig. 5. Mean pileus (cap) diameter (mm) of brown oyster mushroom (*Pleurotus cystidiosus*) using different liming materials

Pileus (cap) diameter

Using different liming materials, the standard liming material (T4) shows the largest pileus (cap) with a diameter of 79.28 mm, followed by the Filter Cake, Rice Hull Ash (RHA) and Wood Ash with mean diameters of 67.19 mm, 60.70 mm, and 57.70 mm respectively (Fig. 5). The T1 had the least pileus (cap) diameter with size of 55.56 mm (Fig. 3). Hence, the average diameter of the largest mushroom pileus (cap) comprising standard liming material and different liming materials was higher than the average diameter in the control (T1). Analysis of variance shows significant differences among Treatment means, T4 is significantly different with T2, T3, and T5. However, T3, T4, and T5 shows comparable to each other. Hence, this agricultural waste can be an alternative liming material for mushroom cultivation.

Conclusion

This research output concludes that agricultural lime still performs best in producing good yield for oyster mushroom cultivation. However, this study sought to contribute in searching for an alternative so not to compromise the production of mushrooms. The filter cake, the rice hull ash and the wood ash are anyway proven to support substrates in producing mushrooms especially in areas that agricultural lime is unlikely to be available. With this, the study claims that search for alternatives to agricultural lime has been revealed.

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