Impact of Different Levels of Calcium Carbonate ($CaCO_3$) on the Growth and yield of Oyster Mushroom (Pleurotus spp.)

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Abstract

This experiment was conducted in the Horticulture department of Raparin University from 21 December to 15 February, to study the effect of different levels of calcium carbonate ($CaCO_3$) on growth and yield of Oyster Mushroom. This experiment included the study of 4 levels of lime ($CaCO_3$), 0, 10, 15, and 20 g/15 kg with 3 replications. The experiment was conducted in a completely randomized design (CRD) with three replications and six treatments. The effect of lime relates to the pH of the media that mushroom grows in it. The pH is an important factor for good production of Oyster mushroom. Most mushrooms grow and yield well at the pH close to light basic or neutral. Lime ($CaCO_3$) is an effective and necessary ingredient in the cultivation of mushroom and commercial cultivation of mushroom depends on the proper adjustment of the substrate pH. Most of the substrates that are used for the mushroom cultivation have pH almost close to neutral.

Keywords: **Mushroom, Lime, Oyster Mushroom, Calcium Carbonate, Pleurotus spp.**

Introduction

Mushroom cultivation is an appropriate technology for the management of agroindustrial residues through bioconversion processes (Miles and Chang, 2004). Mushroom is a fleshy saprophyte fungus, that grows in nature on the decaying organic matter, damp and rotten wood trunk of trees, as well as it grows in damp soil rich in organic substances. It is cultivated for its food value worldwide. There are more than 2000 species of edible mushrooms in nature, but only about 22 species are cultivated (Manzi, et al.; 1999).

People eat mushrooms for their health benefits, texture, and flavor. Mushrooms are healthy foods, with low calories, rich in vitamins (riboflavin, niacin, vitamins B6, B5, B1, K, D, C, and sometimes vitamins C and A) (Ahmed, et al., 2009), chitin, proteins, folic acid, pro-vitamin D ergosterol (Kurtzman, 2005; Moharram, et al., 2008), minerals (potassium, phosphorus, calcium, and sodium) (Manzi, et al., 1999; Stamets., 2005) some essential amino acids, and fiber and it has low cholesterol and fat levels (Rafique, 1996).

Mushroom normally contains protein between 20 and 40%, which is higher than many legume sources like soybeans, peanuts, and vegetarian foods with high proteins (Chang, & Buswell, 1996), (Chang & Mshigeni, 2001). Besides, mushroom has all the essential amino acids especially rich in leucine and lysine, which are necessary for human and do not exist in many staple cereal foods (Sadler, 2003). Increasing consumption of mushroom is suitable to prevent malnutrition; however, they cannot be as an alternative protein source of egg, fish, and meat (Caglarlrmak, & Otles, 2002).

Due to their unique and subtle flavor, mushrooms have been used as food and food flavoring material in soups for centuries (Shin, et al .2007). Oyster mushrooms are a diverse group of saprotrophic fungi, which belong to the genus Pleurotus. Their name originates from the white shell-like appearance of the fruiting body (Kong, 2004). They are good sources of nonstarchy carbohydrates, with high fiber and a moderate amount of vitamins, minerals, and proteins with most amino acids (Croan, 2004). The niacin content is almost 10 times higher than that of other vegetables and the protein content is between 1.6 to 2.5%. Moreover, it has been reported that oyster mushrooms are rich in mineral salts as well as vitamins B complex and C, needed for the human body (Randive, 2012). Pleurotus ostreatus is a mushroom with a pleasant flavor and possesses several proteins, minerals (Ca, P, Fe, and Mg), as well as low carbohydrate and fat quantities, constituting an excellent dietary food (Silva, et al., 2002).

Mushrooms are useful against diabetes, ulcer, and lung diseases (Quimio, 1976). Mushroom is a good source of protein, vitamins, and minerals (Ali Khan et al., 1981). it contains about 85-95% water, 3% protein, 4% carbohydrates, 0.1% fats, 1% minerals and vitamins (Tewari, 1986), and contains an appreciable amount of potassium, phosphorus, copper, and iron but low level of calcium. (Anderson and Feller, 1942). Mushroom protein amount is between that of vegetables and animals (Kurtzman, 1976).

Moreover, it contains an appreciable amount of biotin, pantothenic acid, and niacin (Subramanian, 1986). It grows on industrial and agricultural wastes or in the unused lands as waste in the form of roots, stems, leaves, and straws,

etc. (Zadrazil, 1978). These wastes can be recycled into food and the environment may be less vulnerable to pollution (Hayes, 1979). Mushroom cultivation is highly labor-intensive and crop and land saving and requires short duration that can be welcomed by the poor farmers. Nowadays, the production of mushroom is about 1.5 million tons all over the world.

Mushroom is an excellent source of folic acid and the blood building vitamin that prevents anemia (Alemu & Fisseha, 2015; Tripathi, et al., 2018). Mushroom protein is comparable in nutritive value to muscle protein (Alemu, & Fisseha, 2015). Various bioactive compounds isolated from P. ostreatus culture extracts of Ethiopian higher fungi showed other biological properties including brine shrimp lethality, phytotoxic, anthelmintic, and antiprotozoal, activities (Alemu & Fisseha, 2015).

Calcium Carbonate (CaCO3)

Lime is used in the cultivation of mushroom to enhance the pH of the substrate. Rapid mycelia growth of mushroom (Pleurotus sajor-caju) takes place at pH 6.4-7.8 (Farooq, et al.; 1989).

Material and Method

This experiment was conducted in the field of Horticulture department/Raparin University During 21th December to 15th February. By using dry wheat straw, Mushroom spore, and lime. The dry wheat straw sterilized for three hours in barrel by fire, After cooling were equally distributed into plastic bags of 50×90 cm in size at the rate of 15kg substrate in triplicates, after 70% drying of the wheat straw, it was mixed with four levels of 0, 10, 15, and 20 g of lime for 15 kg of wet wheat straw, the healthy spores with no infection, bought from the market, were mixed with the wet wheat straw in layers then it was tightly pressed and the bag was hung.

Cultivation conditions

The bags were subsequently placed long side down, into a spawn running room at 20-25 °C in the dark and 65-70% relative humidity until completion of the spawn running. After that, the temperature and relative humidity were changed to 19-20 °C and 80-90%, respectively. The bags were slit and the cut portions were folded back. Water was sprayed to maintain moisture in the desired level in the form of fine mist from a nozzle.

After one week, the thread and holes were made over the polythene bags for aeration. Then, they were incubated at 27 °C in the dark and mycelia development was observed and within five days. These bags were watered one time in the first week then after making holes they were watered twice daily. After one month, the mushrooms were ready to harvest and the following characters were measured: Mycelium filaments' wet weight, mushroom surface area, and the number of pinheads).

Watering

Each cultivating bags were irrigated using tap water every morning and evening until 2 flushes of *Pleurotus ostreatus* fruiting bodies appeared.

Harvesting

The first primordia were observed 2-4 days after scratching depending on the types of substrates. The harvesting date also varied depending on the types of substrates. Matured mushrooms were identified by curl margin of the cap and were harvested by twisting to uproot from the base. Mushroom generally matured 48h after appearing the primordia. Data were completely recorded during culture.

Statistical analysis

The data of actively mycelium growth during spawn making and formation of full morphology of *Pleurotus streatus* mushroom and fruiting body were observed during cultivation on the substrate.

RESULTS AND DISCUSSION

1. Mycelium filaments

Mycelium filaments are the main part of the emergence of mushrooms. Due to the fact that lime modifies the acidity of the medium and increases the bag temperature, it was observed in this study that the emergence time of mycelium filaments varied according to different concentrations of lime added to the bags. So that in T0 (0 g/15kg), T1 (10 g/15kg), T2 (15g/15kg), and T3 (20 g/15kg) it took 4.000^{c}, 3.333^{c}, 5.333^{b}, and 6.667^{a} days, respectively and therefore T1 and T3 had the shortest and longest mycelium emergence time, respectively (Table 1). This was consistent with Khan who showed that lime leads to the high acidity of the middle and thus reduces the emergence time of the mycelium (Khan, et al.; 2013).

Table (1). The effect of lime on Mycelium filaments

Treatment	Lime concentrations (g/15kg)	Mycelium filaments emergence time (day)
T0	0	$4.000^{c}\pm 0.000$
T1	10	$3.333^{c}\pm 0.333$
T2	15	$5.333^{b}\pm 0.333$
T3	20	$6.667^{a}\pm 0.333$

the same letter for each character is not significantly different at 5% based on Duncan s Multiple rang test

2. Yield of mushroom

The product yield was measured after 40 days. It was observed that the bags containing 10 g lime gave the largest yield 2.533 kg, which was near to control (T0) that gave 2.100 kg. While in T2 (15g lime) and T3 (20gm lime), the yields were 1.967 kg and 1.767, respectively (Table 2). This confirmed the study conducted by Alemu, 2015, which demonstrated that the high acidity leads to lower mycelium filaments and yields.

Table (2). Effect of lime on the yield of mushroom

Treatment	Lime concentration gm	The yield of mushroom (kg)
T0	0	$2.100^{b}\pm 0.058$
T1	10	$2.533^{a}\pm 0.033$
T2	15	$1.967^{bc}\pm 0.088$
T3	20	$1.767^{c}\pm 0.145$

the same letter for each character is not significantly different at 5% based on Duncan s Multiple rang test

3. Mushroom surface area

The surface area of the mushroom indicates its quality. In this experiment, it was observed that T1 and T3 had mushrooms with the largest and smallest surface area with 6.767cm and 5.367cm, respectively (Table 3), which was agreed with Mowafaq, 2015 and Bakowsky, 6040 who showed that the type of plant medium has a significant effect on the synthesis of amino acids in the fungus, White buttons, and found differences in the content of alanine.

Table (3). The effect of lime on the surface area

Treatment	Lime concentration gm	surface area (cm)
T0	0	$6.133^{b}\pm 0.088$
T1	10	$6.767^{a}\pm 0.145$
T2	15	$5.767^{b}\pm 0.145$
T3	20	$5.367^{c}\pm 0.088$

the same letter for each character is not significantly different at 5% based on Duncan s Multiple rang test

4. Number of pinheads

Table (4) shows the statistical data about the number of primordia (pinheads) formed. The analysis of variance for the number of pinheads showed that the number of primordia was significantly different. The comparison of treatments showed that T1 (30.8) had the maximum number of primordia (pinheads) followed by T0 (28.2), T1 (20.4), and T_3 (11.8). Treatment with 10g lime (T1) and without lime (T0) showed the same level of significance but it was significantly different with T2 (15gm lime) and T3 (20gm lime), respectively. The results were in accordance with the results of various investigations. Khan et al., (2001) tested the oyster mushroom cultivation using different lingo cellulosic substrates and showed that sporocarps formation takes place after (10-12) days while pinhead formation takes place after 7-8 days of spawn running. Further studies revealed that the highest yield of mushroom was observed in the moderate acidity and the formation of the pinhead and fruiting

bodies per bag were also more in moderate acidity. Kimenju et al., (2009) described the suitability of different substrates for the good production of oyster mushroom.

Table (4). The effect of lime on the number of pinheads

Treatment	Lime concentration gm	Number of pinheads
T0	0	$28.333^{b}\pm 0.333$
T1	10	$30.667^{a}\pm 0.333$
T2	15	$20.267^{c}\pm 0.067$
T3	20	$11.933^{d}\pm 0.067$

the same letter for each character is not significantly different at 5% based on Duncan s Multiple rang test

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Appendix