Effect of giving triple super phosphate and dolomite fertilizer on mushroom media (baglog) on production of white oyster mushroom (Pleurotus ostreatus)

M Sianturi*, Bintang and T Sabrina

Department of Agrotechnology, Universitas Sumatera Utara, Medan, Indonesia.

E-mail: *monalisanturi@gmail.com

Abstract. The effort to increase the growth and production of white oyster mushroom (Pleurotus ostreatus), it is necessary to add nutrients to sawdust which will be used as a growing medium for white oyster mushroom. One of the nutrients that need to be added is minerals including Ca (calcium) and Magnesium (Mg) contained in dolomite (CaMg(CO₃)₂) and macronutrients such as phosphorus contained in TSP fertilizer. The aim of this research to determine the effect of giving TSP fertilizer and dolomite on mushroom growing media (baglog) on the production of white oyster mushrooms. This research was conducted in September 2019 to March 2020 in the village, of, Lau Bakeri village, Kutalimbaru District, Deli Serdang Regency The research used a factorial randomized block design with two treatment factors, namely TSP fertilizer (control, 1.2%, 2.4%) and dolomite (control, 1%, 2%, 3%). The results showed the application of triple super phosphate fertilizer and dolomite did not significantly affect to all observation parameters of white oyster mushrooms, but the interaction between triple super phosphate fertilizer and dolomite was able to accelerate the age of harvesting, increase the fresh weight of mushrooms in the first and second harvests and the number of mushroom caps at the third harvest.

1. Introduction

White oyster mushroom (Pleurotus ostreatus) is a type of wood fungus that has good prospects to be developed as food diversification. The nutritional content of white oyster mushrooms is higher than other mushrooms so that it is beneficial for health causing high selling value and market demand for white oyster mushrooms. Based on agricultural statistic data, the utilization of fungi for consumption in 2017 and 2018 was 40.000 and 41.000 tons but production data in 2017 and 2018 was 37.000 and 38.000 tons [1,2]. However, production from oyster mushroom cultivation in Indonesia is still low to meet market or demands. Oyster mushroom production can be optimal if the factors that support its growth such as substrate maturity, additional nutrients, and selection of substrate types [3].

Phosphorus fertilizer is an additional nutrient that can be used for fungal growth [4]. Phosphorus fertilizers can accelerate the growth of mycelium and increase the production of oyster mushrooms as according to research [5] the effect of TSP fertilizer is very significantly different on the initial time of mycelium growth, the time the mycelium filled the growing medium, early emergence of fruiting bodies, amount of fruiting bodies, maximum cap width, the length of mushroom stalk, and bodyweight of the white oyster mushroom. Other nutrients that are also needed by oyster mushrooms are minerals including macro elements such as Ca (calcium) and Mg (magnesium) contained in dolomite.
(CaMg(CO$_3$)$_2$). Elemental magnesium is related to phosphorus metabolism, respiration process, nitrogen fixation, and helps the activity of several enzymes from fungi [6]. Meanwhile, Ca (calcium) is very important in the formation of the middle lamella, cell wall, uptake of nitrate, and increase enzyme activity [7]. The results [8] showed that giving 1% dolomite gave the best results on mycelium growth and fruit bodyweight of brown oyster mushrooms (Pleurotus cystidiosus O.K. Miller) and according to another research [9] that the addition of 1% dolomite in the growing medium gave the best production of pink oyster mushroom (Pleurotus flabellatus Saccardo).

This study aims to determine the effect of giving TSP fertilizer and dolomite on mushroom planting media (baglog) on the production of white oyster mushrooms.

2. Materials and methods

2.1. Research site and materials

This research was conducted at Lau Bakeri Village, Kutalimbaru District, Deli Serdang Regency, North Sumatera in September 2019 to February 2020. The materials and tools are white oyster mushroom seeds, sawdust and bran, TSP fertilizer, (CaMg(CO$_3$)$_2$) dolomite, PP plastic (Polypropylene) 30 cm x 18 cm in size, rubber bands, alcohol, water, baglog cover ring, spatula, cutter, knapsack sprayer, hand sprayer, and analytical scales.

2.2. Design experiment

This research was conducted using factorial randomized block design with two treatment factors, namely TSP fertilizer (control, 1.2%, 2.4%) and dolomite (control, 1%, 2%, 3%). Observation parameters include the time of mycelium filling plant media (baglog), age begins to harvest, fresh weight of white oyster mushroom, and number of white fruiting bodies oyster mushrooms. Measuring time the mycelium meets the planting medium is measured at the beginning of planting or inoculation until the mycelium filled the baglog, age begins to harvest is measured from the beginning of inoculation until the mushrooms are ready to harvest with the characteristic that the cap was fully opened and the edge of the cap was thin, measurement of fresh weight of mushrooms was carried out at harvest by weighing the entire mushroom fruit bodies in each baglog and measuring the amount of fruiting bodies of white oyster mushroom is calculated the average total number of fruit bodies on each harvest and baglog.

2.3. Research implementation

The research implementations are sanitation kumbung, prepare plant media, fermentation, filling plant media, sterilization, cooling down, inoculation, incubation, growing, and handling. Sanitation of the mushroom house (kumbung) is cleaning the whole part from the inside until outside of the mushroom house, planting media and other materials are measured according to need then all the ingredients mixed then added water to taste until the mixture can be clenched but not dripped water, fermented with covering planting media using black plastic for 24 hours, polypropylene plastic filled with fermented planting media, compacted and fitted baglog cover ring of the plastic neck so that the packaging will resemble a bottle, sterilization was conducted at a temperature of 90-105°C ± 6-8 hours, inoculation was conducted by sprinkling seeds of white oyster mushroom into the medium of planting ± 5g, incubation was conducted in rooms with temperatures of 22-300°C until mycelium filling the planting media, white oyster mushrooms are grown in a growing room and placed on research shelves.

2.4. Data analysis

The research data were analyzed by analysis of variance (ANOVA) and continued with using analysis of the Duncan multiple range test at the level of 5%.
3. Results and discussion

The planting of white oyster mushrooms is carried out at a mushroom house located in Lau Bakeri village, Kutalimbaru sub-district, Deli Serdang district. Measurement data from the time parameters of the mycelium to meet the planting media (baglog) and harvesting age are presented in table 1, the fresh weight parameters of mushrooms are presented in table 2 and the parameters of amount of fruiting bodies of white oyster mushroom are presented in table 3.

3.1. Time of Mycelium filling the planting media (baglog) (day)

The time mycelium filled the growing media in all treatments ranged from 32.17 to 42.33 days. The effect of the application of TSP fertilizers and dolomite, the time for the mycelium to fill the planting medium (baglog) was faster when compared to the research of [10] which showed that the 10% rice straw mixture had the fastest mycelium growth at 36.4 days and the 50% rice straw mixture had the longest mycelium growth at 45.2 days.

The D1 treatment (1% of dolomite) resulted in the fastest mycelium filling the planting medium (baglog) at 32.17 days and the P2 treatment (2.4% tsp fertilizer). This is because the calcium and magnesium contained in dolomite will meet the nutritional needs of the fungus in its growth so that it can accelerate the spread of mycelium and age at harvest - according to the literature [8] stated that dolomite contains macro mineral elements such as magnesium and calcium, where both elements is a source of nutrients that are needed by mushrooms for growth of oyster mushroom.

### Table 1. Time of mycelium filling the planting media (baglog) and the age of harvesting.

| Time of Mycelium Filling the Planting Media (baglog) | TSP (%) | Dolomite (%) | Average |
|-----------------------------------------------------|---------|--------------|---------|
|                                                     | D0 (0)  | D1 (1)       | D2 (2)  | D3 (3)  |---------|
| P0 (0)                                              | 33.33   | 33.17        | 33      | 32.5    | 33      |
| P1 (1.2)                                            | 36.33   | 29.33        | 31.33   | 33.33   | 32.58   |
| P2 (2.4)                                            | 42.33   | 32.17        | 34.39   | 34.44   | 38.17   |
| Average                                             | 37.33   | 32.17        | 34.39   | 34.44   |---------|

| Time of Age begins to harvest                        | TSP (%) | Dolomite (%) | Average |
|-----------------------------------------------------|---------|--------------|---------|
|                                                     | D0 (0)  | D1 (1)       | D2 (2)  | D3 (3)  |---------|
| P0 (0)                                              | 73.33cd| 82.33ab      | 78bc    | 75.33bc | 77.25   |
| P1 (1.2)                                            | 95a     | 74bcd        | 73cd    | 85.33ab | 81.83   |
| P2 (2.4)                                            | 81.67bc | 62d          | 85ab    | 87.67ab | 79.08   |
| Average                                             | 83.33   | 72.78        | 78.67   | 82.78   |---------|

Note: The numbers followed by the same notation were not significantly different based on Duncan's Multiple Range Test at the 5% level.

3.2. The age of harvesting (day)

The age of harvesting for each treatment ranged from 72.8 to 95 days. Age of harvesting with triple super phosphate fertilizer and dolomite treatment was slower when compared with the research of [4] which showed that the fastest age of harvesting was 61.33 days by reed planting media treatment and 1% phosphorus fertilizer application and the longest harvesting age was 76.67 days by treatment. rice straw planting medium and 0.5% phosphorus fertilizer.

In the dolomite treatment, the dose of 1% dolomite gave the fastest age of harvesting. This is because the fastest of the time the mycelium filling the growing media (baglog) is by D1 treatment (1% dolomite). Basad on [3] the faster the mycelium spreads out diffuse the faster the formation of the fruiting bodies. The addition of dolomite to the planting medium can meet the nutritional needs for the growth of white oyster mushrooms, thereby triggering enzyme activators and accelerating the growth of mycelium and the formation of fruit bodies. According to [8] dolomite contains macro mineral
elements such as magnesium and calcium, both of which are a source of nutrients that are needed by mushrooms for their growth.

The results showed that the interaction between TSP and dolomite had a significant effect on the age at harvest. The DMRT results showed that P2D1 treatment was not significantly different from P0D0, P1D1, and P1D2 treatments but significantly different from other treatments.

Table 2. Average data of fresh weight of white oyster mushrooms.

| Harvest | TSP (%) | D0 (0) | D1 (1) | D2 (2) | D3 (3) | Average |
|---------|---------|--------|--------|--------|--------|---------|
| 1       | P0 (0)  | 50.83^b| 76^ab  | 88.6^7a| 91.5^a | 76.75   |
|         | P1 (1.2)| 88.6^a | 73.8^3ab| 76^ab  | 74.6^7ab| 78.2^9  |
|         | P2 (2.4)| 89.3^3a| 90.5^a | 68.8^3ab| 75.1^7ab| 80.9^6  |
|         | Average | 76.28  | 80.11  | 77.83  | 80.4^4  |
| 2       | P0 (0)  | 29.5^d | 61^ab  | 74.5^a | 67.5^3ab| 58.1^3  |
|         | P1 (1.2)| 59^ab  | 64^ab  | 79^a   | 50.8^3cd| 63.2^1  |
|         | P2 (2.4)| 79.3^3a| 46.6^7cd| 63.3^3ab| 56.3^3ab| 61.4^2  |
|         | Average | 55.9^4 | 57.2^2 | 72.2^8 | 58.2^2  |
| 3       | P0 (0)  | 25     | 43     | 59     | 23     | 37.5    |
|         | P1 (1.2)| 29     | 38.83  | 47     | 56.1^7 | 42.7^5  |
|         | P2 (2.4)| 37     | 32.5   | 38.1^7 | 39.3^3 | 36.7^5  |
|         | Average | 30.33  | 38.11  | 48.05  | 39.5    |

Note: The numbers followed by the same notation were not significantly different based on Duncan's Multiple Range Test at the 5% level.

3.3. Mushroom fresh weight
Mushroom fresh weight in each treatment at the first harvest ranged from 50.82 to 91.5 grams. Meanwhile, the second harvest ranged from 29.5 to 79.3 grams and the third harvest ranged from 25 to 56.17 grams. The effect of TSP and dolomite fertilizers treatment resulted in a higher fresh weight of mushrooms than the research [4] which showed the lowest fruit weight of the mushrooms with an average wet weight was 47.17 grams in the sawdust media treatment and the highest fruit weight with an average wet weight was 63 grams in the treatment of reeds and fertilizer media, phosphorus 1%.

From the measurement results of mushroom fresh weight in all harvests, the lowest fresh weight of mushrooms was produced by control treatment. This is because the addition of dolomite which contains calcium and magnesium enriches the mineral content in the planting media (baglog) so that the source of nutrition is adequate and supports the growth of mushroom fruiting bodies. This is in accordance with research [9] that the addition of 1% dolomite resulted in the highest average fruit bodyweight of pink oyster mushrooms. The results of this study are in accordance with the literature [11,12] which stated that calcium functions to strengthen cell walls while magnesium acts as an activator of various types of enzymes related to protein and carbohydrate metabolism.

The results showed that the interaction between TSP fertilizer and dolomite significantly affected the fresh weight of the harvest at the first and second harvests.
Table 3. Number of fruiting bodies of white oyster mushroom with application of triple super phosphate fertilizer and dolomite on mushroom media.

| Harvest | TSP (%) | D0 (0) | D1 (1) | D2 (2) | D3 (3) | Average |
|---------|---------|--------|--------|--------|--------|---------|
|         |         | fruit  |        |        |        |         |
| 1       | P0 (0)  | 5      | 6.83   | 8.83   | 8.5    | 7.29    |
|         | P1 (1.2)| 5.83   | 6.17   | 6      | 6.33   | 6.08    |
|         | P2 (2.4)| 6.67   | 10.17* | 7.5    | 8.17   | 8.13    |
|         | Average | 5.83   | 7.72   | 7.44   | 7.67   |         |
| 2       | P0 (0)  | 3      | 3      | 6      | 5      | 4.38    |
|         | P1 (1.2)| 4      | 6.33   | 6      | 5      | 5.33    |
|         | P2 (2.4)| 6.17   | 4.5    | 5.17   | 5.33   | 5.29    |
|         | Average | 4.39   | 4.61   | 5.72*  | 5.28   |         |
| 3       | P0 (0)  | 3.17d  | 4.33bcd | 5.5abc | 4^d    | 4.25    |
|         | P1 (1.2)| 3.5^ed | 2.83d  | 5.67^ab | 7.17^a | 4.79    |
|         | P2 (2.4)| 3.5^ed | 4.17bcd | 4.5^bc | 4.17^ed | 4.08    |
|         | Average | 3.39   | 3.78   | 5.22   | 5.11   |         |

Note: The numbers followed by the same notation were not significantly different based on Duncan's Multiple Range Test at the 5% level.

3.4. Amount of fruiting bodies of white oyster mushroom (fruit)
The amount of fruiting bodies of white oyster mushroom in all treatments in the first harvest ranged from 5 to 10.17 fruits, meanwhile in the second harvest ranged from 3 to 5.72 fruits and the third harvest ranged from 3.17 to 7.17 fruits. The effect of giving TSP fertilizer resulted in a lower number of fruiting bodies of white oyster mushroom than the results of the study [4] which showed that the highest number of fruiting bodies is 10.44 fruits were produced by 1% tsp fertilizer treatment and the smallest number of fruiting bodies is 8.11 fruits at the control.

The results showed that the interaction between TSP and dolomite fertilizers had a significant effect on the number of fruiting bodies in the third harvest. The DMRT results showed that the P1D3 treatment which produced the largest number of fruiting bodies in the third harvest was not significantly different from the P0D2 treatment but significantly different from other treatments.

4. Conclusions
The application of tsp and dolomite fertilizers did not significantly affect all observation parameters of white oyster mushrooms, but the interactions between both treatment factors were able to accelerate the age of harvesting, increase the fresh weight of mushrooms in the first and second harvests, and the number of fruiting bodies at the third harvest.

References
[1] Badan Pusat Statistik Indonesia [Indonesian Central Bureau of Statistics] 2017 Statistik Tanaman Sayuran dan Buah-buahan Semusim Indonesia [Statistic of Seasonal Vegetable and Fruit Plants Indonesia] (Jakarta: BPS-Statistics Indonesia [Indonesian Central Bureau of Statistics]) 05120.1808 pp 49-50
[2] Pusat Data dan Sistem Informasi Pertanian [Center for Agricultural Data and Information Systems] 2018 Statistik Konsumsi Pangan [Statistics for Food Consumption] (Jakarta: Sekretaris Jendral Kementerian Pertanian [Secretary General of the Ministry of Agriculture]) pp 65
[3] Sugianto A 2013 Teknologi Inovasi TEL Jamur Tiram Putih untuk Melipatgandakan Produksi [Technology of TEL Innovation of White Oyster Mushroom to Multiply Production] (Malang: Intimedia)
[4] Draski H and Ernita 2013 Pengaruh jenis media dan dosis fosfor terhadap pertumbuhan Jamur Tiram Putih (Pleurotus ostreatus) [The effect of kind of media and fosfor dosage on growth of White Oyster Mushroom] J. Dinamika Pertanian 28 3 pp 203-10
[5] Ding F J, Syahfari H and Napitupulu M 2019 Pengaruh media tumbuh dan pemberian pupuk TSP pada budidaya Jamur Tiram Putih (Pleurotus ostreatus) [Effect of growing media and the addition of TSP fertilizer in cultivation of oyster mushroom] J. AGRIFOR 18 1 pp 97-108
[6] Sugianto A 2017 Pembangunan Pedesaan Melalui Penerapan IPTEK Wirausaha Jamur Kayu [Rural Development through the Application of Science and Technology Enterpreneurial of wood mushroom] (Malang: Intimedia)
[7] Kurniawan Y and Widodo 2009 Keragaan empat varietas padi pada pemberian Amelioran tanah ultisol, abu sekam dan dolomit di lahan gambut [Responses of four local varieties on Ameliorant of ultisol, hull ash, and dolomite application in peat soil] J. Akta Agrosia 12 1 pp 45-50
[8] Masefa L, Nurmiati and Periadnadi 2016 Pengaruh kapur dan dolomit terhadap pertumbuhan Miselium dan produksi Jamur Tiram Cokelat (Pleurotus cystidiosus) [The effect of calcite and dolomite to the Mycelium growth and production of Brown Oyster Mushroom] Journal of Natural Science 5 1 pp 11-20
[9] Saputri R, Periadnadi and Nurmiati 2016 Pengaruh kapur dan dolomit terhadap pertumbuhan Miselium dan produksi Jamur Tiram Merah Muda (Pleurotus flabellatus) [The effect of calcite and dolomite to Mycelium growth and production of Pink Oyster Mushroom] Journal of Natural Science 5 1 pp 1-10
[10] Rambey R, Simbolon M and Siregar EBM 2019 Growth and Productivity of oyster mushrooms (Pleurotus ostreatus) on media rice straw mixed with sawdust IOP Conf. Series: Earth and Environmental Science 454 2020 012082 pp 3
[11] Warmada I W and Titisari A D 2004 Agromineralogi (Mineralogi untuk Ilmu Pertanian) [Agromineralogy (Mineralogy for Agricultural Sciences)] (Yogyakarta: UGM University)
[12] Winarno FG 2004 Kimia Pangan dan Gizi [Food Chemistry and nutrient] (Jakarta: Gramedia Pustaka Utama)