World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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The growth and productivity of gray oyster mushrooms (*Pleurotus sajor-caju* (Fries) Singer) in the Limau Manis Area of Padang City

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World Journal of Advanced Research and Reviews, 2023, 17(02), 649–657

Publication history: Received on 05 December 2022; revised on 18 February 2023; accepted on 20 February 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.17.2.0026

Abstract

The research about The Growth and Productivity of Gray Oyster Mushrooms (*Pleurotus sajor-caju* (Fries) Singer) in The Limau Manis of Area Padang City was conducted from February to July 2021 at the Laboratory of Microbiology, Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University. The research was aimed to observe the growth of gray oyster mushrooms mycelium on corn and bag log media, to determine the productivity value of gray oyster mushrooms on bag log media. The research was conducted by survey methods and analyzed descriptively using images, tables, and graphs. The results showed that the average growth of gray oyster mushroom mycelium on corn media was 0.83 cm/day and 1.02 cm/day on bag log media. The highest productivity of gray oyster mushrooms reached 48.59% with the highest total body weight of 388.73 g. The highest number of fruiting body cap is 43 pieces. While the weight of the heaviest fruiting body cap reached 30.6 g with the largest cap diameter was 17.5 cm.

Keywords: Fruiting body cap; Gray Oyster Mushrooms; Mycelium Growth; Productivity

1. Introduction

Pleurotus spp. or oyster mushroom is a widely cultivated and traded in the market and popular as food. Oyster mushrooms are wooden mushrooms that come from the Basidiomycetes group. This mushrooms is called oyster mushroom because of the cap is circular like an oyster shell [1]. Oyster mushrooms are one of the most easily cultivated high-value consumption mushrooms because they can be grown in various types of substrates and have high adaptability to the environment [2]. The native habitat of oyster mushrooms is in highland areas but these mushrooms can be cultivated in lowland areas by conditioning their maintenance according to their natural habitat [3].

Pleurotus spp. consists of several varieties namely white oyster mushrooms, brown oyster mushrooms, yellow oyster mushrooms, pink oyster mushrooms, and gray oyster mushrooms (*Pleurotus sajor-caju*). Nutritional content of oyster mushrooms include protein (10.5-30.4%), fat (1.7-2.2%), carbohydrates (56.6%), thiamin (0.20 mg), riboflavin (4, 7-4.9 mg), niacin (77.2 mg), and calcium (314 mg) [4]. The content of oyster mushrooms can be used as an alternative protein source because it contains 20 essential amino acids. Protein content in oyster mushrooms contains 19-35% higher protein compared to rice (7.38%) or wheat (13.2%) [5]. Gray oyster mushrooms have almost the same content as oyster mushrooms in general, namely in 100 g of oyster mushrooms contain 27% protein, 1.6% fat, 58% carbohydrates, 7.5% - 8.7% fiber and has a durability of 5 days outside the cooling machine [6].

Maryanti [7] research obtained the result that the productivity of white oyster mushrooms in Alahan Panjang from the first harvest to the last harvest obtained a percentage of productivity of 55.45% with 6 times the harvest in one bag log. This is in accordance with the opinion of Suriawiria [8] during the growing season, harvesting can be done between 4-8 times depending on the content of planting substrates, mushroom seedlings, as well as the environment during

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maintenance. The success of mushroom cultivation is determined by the value of Biological Efficiency (BE), it is biologically efficient in determining the productivity of oyster mushrooms. The higher the value of BE, the better the cultivation of the mushroom.

Furthermore, the gray oyster mushroom has a great benefits and potential to be cultivated and need to be explored because there is no previous data on it. It would be more information that has high organic matter. The aim of this study was to observe the growth of gray oyster mushroom mycelium on corn and bag log media and determine the productivity value of gray oyster mushrooms on bag log media in the Limau Manis Area of Padang City.

2. Material and methods

2.1. Materials and tools

The tools used in this study are paper, rubber band, paper label, ring, autoclave, plastic bag log, spatula, marker, sterile paper, sterile tissue, bag log rack, scales, and bunsen. While the required ingredients are seeds F1 of gray oyster mushrooms (*Pleurotus sajor-caju*), sawdust, bran, lime (CaCO3), spiritus, aquadest, and alcohol 70%.

2.2. Research methods

This research was conducted using survey methods and analyzed descriptively using images and graphs. The procedures in the laboratory are preparation of mushroom seedlings, preparation of corn seed media, preparation of sawdust media, mixing media, composting, baglog making, sterilization, inoculation, and incubation. While the field observations are mycelium length measurement, total fruiting body weight, number of fruit body caps, weight of the heaviest fruiting body cap, the largest pileus diameter, and biological efficiency (BE).

3. Results and discussion

3.1. Mycelium Growth Rate on Corn Media

The result of mycelium growth rate on corn media was presented in Figure 1. That shows significant differences among days of observation. The results obtained from the growth of the gray oyster mushrooms mycelium on corn media are as follows

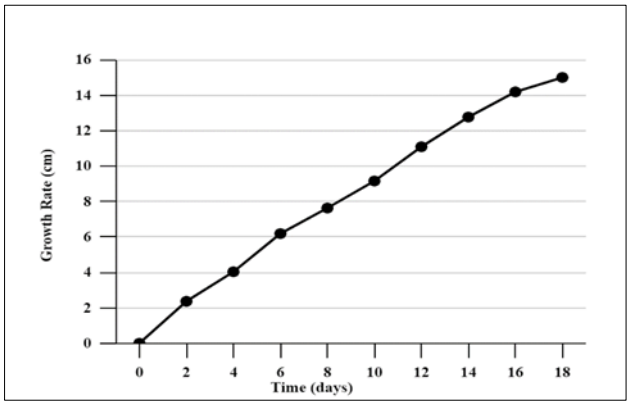

Figure 1 Mycelium Growth Rates of Gray Oyster Mushrooms (*Pleurotus sajor-caju* (Fries) Singer) Cultivated on Corn Media for 18 Days

According to Figure 1, the mycelium of gray oyster mushrooms needs 18 days to fully grow in corn media. Mycelium growth of gray oyster mushrooms was observed once within 2 days and the mycelium length increased by an average of 1.67 cm. The growth continued to increase from the first day to the 18th day of observation. The results showed that the mushroom mycelium could grow as long as 15 cm to fully cover the substrate surface in the bottle used. The growth rate of gray oyster mushrooms on corn media was 0.83 cm/day. Andriani (2019) [9] reported that the average length of oyster mushroom mycelium on corn media was 7.6 cm on the 14th day of observation with growth rate of 0.54 cm/day.

The increase in the length of oyster mushroom mycelium is influenced by the nutrients contained in the media and the ambient temperature as another important factor. Hoa and Wang (2015) [10] reported that mycelium growth of oyster mushrooms influenced by various carbon sources contained in the media used such as glucose, sucrose, and mollases were favorable to the mycelium growth of oyster mushrooms.Temperature is a very important environmental factor for the mycelium growth of fungi. The optimum temperature for the mycelium growth of oyster mushrooms was 25°C-30°C. The results reported by Choi *et al.* (2003) [11] and Kashangura (2008) [12] demonstrated that the mycelium growth and fruiting formation of oyster mushroom species were affected by temperature and they could grow at high temperature as summer season in tropical regions. Nurhajadi and Martawijaya (2011) [13] reported that the temperature is a very important factor for the growth of oyster mushrooms. The ideal temperature for oyster mushroom growth is 18°C-30°C. The optimum temperature for mycelium growth is around 25°C-28°C.

Figure 2 Gay Oyster Mushroom's Mycelium on Corn Media

Figure 2 shows mycelium growth on corn media on the 8th and 18th days after the inoculation process. Mycelium growth was affected by carbon sources and sucrose concentration on media used. Corn contains sugar (monosaccharide) which is a carbon source for the growth of oyster mushrooms. It is similar to a result reported by Hoa and Wang (2015) [10] mentioned that carbohydrates which play key roles as structural and storage compounds in the cell are distinguished as monosaccharides (glucose or dextrose, fructose, and galactose), disaccharides (sucrose and lactose), and polysaccharides (cellulose and starch). Those kinds of sugar are needed to support the growth of mycelium.

Corn kernels were used in this study because of its nutrient content such as monosaccharide which is a carbon source for mushroom growth. Highest mycelium colony diameters and lengths were obtained from the media containing glucose, fructose, and sucrose [10]. Sucrose was the best carbon source for the mycelium growth of mushrooms [14]. Moreover, the preference for glucose, fructose, and sucrose may be due to the ease with which it was metabolized to produce cellular energy for the growth of the organism.

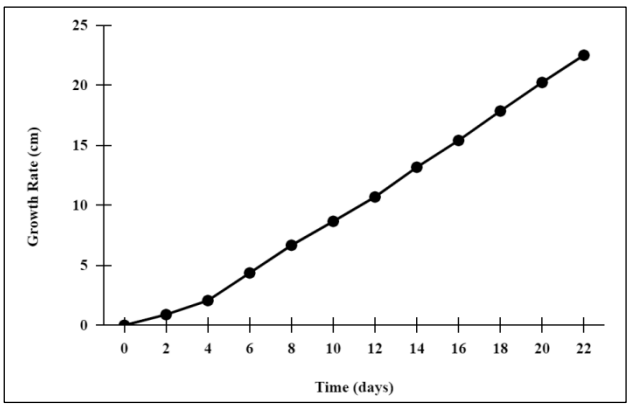

Figure 3 Mycelium Growth Rate of Gray Oyster Mushrooms (*Pleurotus sajr-caju* (Fries) Singer) Cultivated on Baglog Media

Based on Figure 3 above, the length of mycelium growth of gray oyster mushroom (*Pleurotus sajor-caju* (Fries) Singer) on bag log media was 22.5 cm. The average length increase of gray oyster mushroom mycelium during the observation time is 2.04 cm/2 days. It means, the growth rate of gray oyster mushrooms mycelium on bag log media was 1.02

cm/day. A study done by Ibrahim *et al.* (2017) [15] showed that the growth rate of mycelium of *Pleurotus sajor-caju* was 1.2 cm/day and took 37 days to reach 18.5 cm fully covered the substrate.

Figure 3 showed that mycelium filled the bag log in just 22 days. A study reported by Wiardani (2010) [16] mentioned that the time it takes for the mycelium to fill the bag log ranges from 30-50 days. Mycelium growth is influenced by nutrients contained in the growth media and ambient temperature. Mycelium needs some chemical components to grow such as glucose, nitrogen, calcium, potassium, and phosphorus. The greater the composition of sawdust, the content of cellulose, hemicellulose, and lignin will also increase. High cellulose and lignin content will support the growth of fungal mycelium [17].

Figure 4 Mycelium Growth of Gray Oyster Mushroom (*Pleurotus sajor-caju* (Fries) Singer) on Bag Log

Based on figure 4, it can be seen that mycelium has spread around the upside of the bag log in the first week after inoculation and getting longer in the second week. It spread to all the surfaces of the bags in the third week and grew thick. The average time for growth of gray oyster mushroom mycelium was 25 days with 600 g of bag log weight [18]. This might be caused by the presence of a useful substance for mushroom growth such as sugar, minerals, vitamins even some growth hormones contained in substrate media.

Nevertheless, the result for the mycelium to fill up the bags in this study was relatively the same as compared to the result obtained from the study done by Shah *et al* (2004) [19] and Mondal *et al*. (2010) [20] which took 21-24 days. The faster growth of mycelium might be due to suitable temperature and humidity in the mushroom house (temperature: 23°C-30°C and relative humidity: 89%-100%). The study done by Chazali and Pratiwi (2009) [21] also showed that oyster mushroom mycelium can grow between 23°C-28°C with an optimum temperature of 25°C.

3.2. Gray Oyster Mushrooms (*Pleurotus sajor-caju*) Productivity

The gray oyster mushrooms (*Pleurotus sajor caju*) was harvested several times during the productivity period. From the harvesting process obtained the total weight of fruiting bodies, the number of fruiting body caps, the heaviest fruiting body caps, and the largest pileus diameter per bag log were observed. The recapitulation of gray oyster mushrooms productivity (total harvest, number of fruiting body caps, the heaviest fruiting body caps, the largest pileus diameter, total weight of fruiting, and productivity percentage) can be seen in Table 1 below.

Table 1 The Average Productivity of Gray Oyster Mushroom (*Pleurotus sajor-caju* (Fries) Singer) in The Limau Manis Area, Padang City (@700 g).

Total harvest (times)	Number of fruiting body caps	The heaviest fruiting body caps (g)	The largest pileus diameter (cm)	Total weight of fruiting body (g)	Productivity percentage (%)
3	36.71	18.65	9.92	301.12	37.64

3.3. Total Harvest

Total harvesting data of gray oyster mushroom per bag log can be seen in Table 1 above. The gray oyster mushroom was harvested several times during the productivity period. From the harvesting process obtained the total weight of fruiting bodies, the number of fruiting body caps, the heaviest fruiting body caps, and the largest fruiting body cap diameter per bag log were observed. Harvesting of gray oyster mushrooms counted from the beginning to the last time of harvesting. From observations made during the study, it was found that the average harvest of gray oyster mushrooms was 3 times. Most harvests were obtained from bags numbers B1, B3, B5, and B6 with a total of 4 harvesting times. The result in this study was relatively different as compared to the result obtained from the study done by Maryanti (2017) [7] which showed that oyster mushrooms can be harvested 4-6 times.

This contrasting result might be caused by media composition and environmental factors. The minimum harvest period obtained in this research is caused by the high temperature around the mushroom house. This causes the mushroom bag's media to harden and dry easily. Environmental conditions in the mushroom house must be considered and maintained properly because mushrooms need low air temperatures and high humidity during their growth period. Temperature, humidity, and light are the basic needs for the growth and development of mushrooms. The increase in room temperature, competitive molds, and microbes may reduce the yields of the mushroom crop [22].

3.4. The Number of Fruiting Bodies Cap

The number of gray oyster mushrooms (*Pleurotus sajor-caju* (Fries) Singer) fruiting body caps were calculated at each harvest period from each bag. The criteria for the measurement of the gray oyster mushroom caps are with the provisions of the minimum size of the cap was 0,5 cm. The number of gray oyster mushroom fruiting body caps at each harvest period was added up to obtain the total of the caps. In this study (Table 1), the highest number of fruiting body caps was 43 caps, while the least number was 30 caps with a media weight of 700 g. The average number of total fruiting body caps produced by all bags during the harvest period was 36 caps. This is different from the results of research conducted by Purnomo (2013) [23] which showed that each bag of oyster mushrooms with sawdust media will produce an average number of oyster mushroom caps of 18 caps. This difference occurs due to several factors such as internal factors and external factors.

Internal factors are nutrients contained in the mushroom growing media. In this study, sawdust was used as a substrate for mushroom growth. The quality of the growing media greatly affects the formation of the mushroom fruiting body cap. The more nutrients needed by the fungus in the growing medium, the greater the productivity results obtained. The similarities also shown in Muffarihah's research [24] stated that the number of primordia or pinheads that grow will affect the number of mushroom fruiting bodies. If there are many primordia, the number of fruiting bodies formed is also large. This is influenced by the nutrients contained in the mushroom growing media.

The external factors are the ambiance around mushroom houses including humidity and temperature. Based on the observations made in this study, the ambient temperature around mushroom houses ranged from 22°C-31°C with a humidity of 80%-95%. The optimum temperature for the productivity of total fruiting bodies ranged from 16°C-23°C with a humidity of 95%-98% [5,21]. The humidity must be maintained so as not to inhibit the growth and development of the mushroom fruiting body cap. One way to maintain optimal humidity is to water bag logs regularly in the morning and afternoon. However, the result for the number of fruiting body caps in this study was relatively the same as compared to the result obtained from the study done by Maryanti (2017) [7] which got the highest total fruiting body of 44 caps.

3.5. The Heaviest Fruiting Body Caps

The weight of the mushroom fruiting body cap was calculated at each harvest period in each bag log until the harvest period was completed. Based on Table 1, it can be seen that the weight of the heaviest fruiting body cap of gray oyster mushroom from 7 bag logs observed with a media weight of 700 g resulted in the heaviest fruiting body cap from B6. A study that was done by Maryanti (2017) [7], showed that there were significant differences in the weight of the heaviest fruiting body cap. Based on her study, the weight of the heaviest fruiting body cap was significantly heavier (110 g) whereas in this study the heaviest fruiting body cap was only 30.6 g. This was caused by internal factors and external factors. The main factors that affect the growth of gray oyster mushrooms are the substrate or growing medium and environmental factors such as temperature and humidity.

The growth of mushroom fruiting bodies is also influenced by the content of oxygen and carbon dioxide [21,25]. The intake of oxygen and carbon dioxide must be sufficient to support the growth of the mushroom fruiting body. If the mushroom fruiting body wilts or dies, then the mushroom fruit body weight is not obtained. The weight of the mushroom fruiting body was an indicator of productivity value. The higher weight of the mushroom fruiting body, the better the productivity value of that mushroom [26,27].

The weight of the mushroom fruiting body cap is also influenced by the number of pinheads that grow on the substrate. The more the number of pinheads, the smaller the size of the cap that grows. This is supported by Purnomo (2013) [23] stated that the more mushroom caps, the smaller the diameter, while the smaller the number of pinheads, the larger the diameter of the mushrooms. Bag logs that have a lot of mushroom caps will have less room to widen because they overlap with other caps.

3.6. The Largest Pileus Diameter

The largest size of the pileus diameter of gray oyster mushroom (*Pleurotus sajor-caju*) that had been harvested from the harvesting period was chosen. In this study (Table 1) of 7 bag logs observed, the diameter of pileus of the gray oyster mushroom reached 17.5 cm in bag log number 5. Based on the results of Maryanti's research [7], the diameter of the oyster mushroom pileus can vary between 10 cm-17.5 cm. Oyster mushrooms have a cap diameter of about 4 cm-15 cm or even more and are shaped like an oyster shell [28]. The size of the pileus diameter of oyster mushrooms can vary due to the quality of the substrate in the growing medium and also environmental factors.

The diameter of the pileus of the oyster mushroom can be influenced by the quality of the substrate. In addition, it can also be influenced by environmental factors where the fungus grows. The number of mushroom fruiting body caps that grow can also affect the diameter of the pileus because the more mushroom fruiting caps that grow in one bag log clump will reduce the growth space for these mushrooms. According to research by Rahma (2014) [29], the largest pileus diameter is produced by mushroom bag logs that have few fruiting body branches, on the contrary, mushroom bag logs with many branches will have smaller pileus diameters. This happens because of growing individual competition resulting in variations in the width of the pileus diameter.

3.7. Total Weight of Fruiting Body

The total weight of the fruiting body was collected from the first harvesting until the last harvesting cycle. Harvesting time is indicated by fruiting body formation. The harvesting process required the grower to pull the mushroom fruiting bodies from the substrate. The weight of fruiting bodies was counted by using digital scales. Measurements were carried out on 7 bags that had been determined with a bag's media weight of 700 g per unit.

The total weight of the gray oyster mushroom (*Pleurotus sajor-caju* (Fries) Singer) from 7 bags with a media weight of 700 g (Table 1) was found to reach ≤ 388.73 g. The average weight of the gray oyster mushroom fruiting body obtained was 301.12 g. Harvesting was done by pulling out each mushroom clump so that fresh and blooming mushroom fruiting bodies were obtained. If the mushroom was not harvested on time, the fruiting body will rot and cause pests or other contaminating fungi to appear. This will inhibit the growth and productivity of gray oyster mushrooms in the next harvest period. The fungus associated with oyster mushroom growing media such as *Aspergillus* spp.*, Trichoderma* spp.*, Mucor* spp.*, Penicillium* spp.*, Fusarium* spp.*, Alternaria* spp.*, Cladosporium* spp.*, Monilia* spp.*, Helminthosporium* spp.*, Coccidioides* spp.*,* and *Scedosporium* spp. was competitor fungus or may cause disease in cultivated mushrooms [30,31].

Fruiting body formation of *Pleurotus sajor-caju* was indicated by pinhead emergence. In this study, it took 2-3 days for pinhead formation and 4-5 days for fruiting bodies formation. Based on a study done by Ibrahim *et al.* (2017) [15] mentioned that pinhead emergence is an important factor in mushroom cultivation which indicates the initial stage of fruiting bodies formation. It took 8 days for pinhead emergence and 9 days for fruiting bodies formation. Fruiting body formation is also affected by growing media quality and ambient temperature in the mushroom house.

3.8. Biological Efficiency

Biological efficiency, which is used to evaluate the efficiency of substrate conversion in mushroom cultivation, was determined as a ratio of the biological yield harvested to the dry weight of each substrate. The percentage of gray oyster mushroom productivity was obtained from 7 bag logs observed with a media weight of 700 g and the total weight of the gray oyster mushroom fruiting body was measured until the harvest was complete, then the biological efficiency (BE) was calculated.

Based on table 1, it can be seen that the percentage of gray oyster mushroom productivity in the Limau Manis area, Padang City reached 48.59%. This is caused by environmental factors where the fungus is grown. Temperature and humidity are important factors that affect the growth of gray oyster mushrooms. According to Maryanti's research [7] regarding the productivity of white oyster mushrooms in Alahan Panjang, Solok Regency, West Sumatra, the percentage of white oyster mushroom productivity reached 55.45%. Differences in types, temperature, and humidity in the study area are the main factors that affect the percentage of oyster mushroom productivity. White oyster mushrooms is the most cultivate oyster mushrooms in the field. White oyster mushroom is easier to cultivate than gray oyster mushrooms because white oyster mushroom can be grown in the optimum temperature of 22°C-30°C, while gray oyster mushrooms needs lower temperature than that. The Limau Manis area has a higher temperature than the Alahan Panjang area. The average daily temperature in the Limau Manis area is around 26°C-31°C, while the Alahan Panjang area has a lower temperature of around 16°C-22°C.

In this study, the productivity of gray oyster mushrooms in the Limau Manis area, Padang City can be harvested 4 times with the highest productivity percentage of 48.59%. Shrestha *et al.* (2021) [32] reported, in the real ground, the BE may be affected by several factors such as substrate composition, ambient environment, mushroom strain, disease pest, and

other multiple management factors. Saputra (2015) [33] mentioned during the harvesting period, mushrooms can be harvested between 4-8 times and the number of mushrooms obtained per period can reach 600 g per bag log, while the substrate weight of 1 kilogram of growing media produces a productivity percentage of 50%.

Meanwhile, during the growing season, mushroom harvesting can be carried out between 4-8 times [8]. The success of oyster mushroom cultivation is determined by the biological efficiency (BE). The higher the biological efficiency value, the higher the success rate of oyster mushroom cultivation. However, with the increase in room temperature, competitive molds and microbes may reduce the BE of the mushroom crop [22].

Based on the results of this study (Table 1), it can be seen the productivity of gray oyster mushroom (*Pleurotus sajor-caju* (Fries) Singer) in the Limau Manis area, Padang City by selecting 7 bag logs observed, with a media weight of 700 g. The yield of each bag log was obtained by measuring the total weight of the fruiting body, the number of fruiting body caps, the weight of the heaviest fruiting body cap, and the diameter of the largest pileus. The total weight of the largest mushroom fruiting body was in bag log 5 of 388.73 g with 4 harvest times, having the highest number of fruiting body caps namely 43 pieces with a productivity percentage of 48.59%. The weight of the heaviest fruiting body cap was obtained from bag log 5 of 30,6 g and had a diameter of 17,5 cm of the pileus.

Before determining the yields of gray oyster mushrooms (*Pleurotus sajor-caju*), measurements were carried out on various yield components. It was observed that the yield components of the *Pleurotus sajor-caju* were found to be affected by the use of different substrates even though it was not significant. In this study, the substrate that was used to grow media of gray oyster mushrooms (*Pleurotus sajor-caju*) was sawdust. Based on the research done by Girmay *et al.* (2016) [34], paper waste resulted in relatively better growth in terms of diameter and thickness of pileus, and diameter and length of the stipe. On the other hand, the number of well-developed fruiting bodies was significantly higher in the culture of cotton seed than the other substrates.

The lowest number of fruiting bodies was found on sawdust, while it was similar to wheat straw and paper waste. This could be indicative of the fact that the use of different substrates may affect the percentage of effective fruiting bodies formed. The study confirmed that the biological efficiency (BE) also varied significantly among the different substrates used. Variable ranges of BE have been reported when different lignocellulosic materials were used as substrates for the cultivation of oyster mushrooms [35].

In this study, the performance of gray oyster mushroom growth and yield in sawdust substrate was minimum. Obodai *et al* (2002) reported, this could be attributed to the fact that lignocellulosic materials in sawdust are generally low in protein content and thus insufficient for the cultivation of mushrooms. Therefore, sawdust substrate for mushroom production should undergo a period of composting to break down the cellulose and lignin components of the establishment of mushroom mycelia. It may also require additional nitrogen, phosphate, and potassium [34].

4. Conclusion

Based on research that has been conducted on The Productivity and Growth of Gray Oyster Mushroom (*Pleurotus sajor-caju* (Fries) Singer) in the Limau Manis Area, Padang City, the following conclusions are obtained:

- The average growth of gray oyster mushroom mycelium on corn media was 0.83 cm/day and 1.02 cm/day on bag log media.
- The highest productivity of gray oyster mushrooms (*Pleurotus sajor-caju* (Fries) Singer) reached 48.59% with the highest total body weight of 388.73 g. The highest number of fruiting body caps is 43 pieces. While the weight of the heaviest fruiting body cap reached 30.6 g with the largest pileus diameter of 17.5 cm.

Compliance with ethical standards

Acknowledgments

We would like to acknowledge to all members of the laboratory for their discussions and comments. The authors also appreciate the reviewers of the journal their valuable comments and suggestions to improve the quality of the manuscript.

Disclosure of conflict of interest

There is no conflict of interest between the authors of this research work. The authors agreed and assigned in hand to all matters arising to this piece of research work.

References

[1] Meinanda, E. Panen Cepat Budidaya Jamur. Bandung; 2013

[2] Kurt S, Buyukalaca. Yield Performances changes in enzyme activities of Pleurotus spp. (P. ostreatus and P. sajor-caju) cultivated on different agricultural wastes. Biores. Technology. 2010; Vol 101:3164-3169

[3] Chazali S, Pratiwi PS. Usaha Jamur Tiram Skala Rumah Tangga. Jakarta. Penebar Swadaya; 2009

[4] Jakiyah E, Hasni UH, Dwi NRS. Persilangan Jamur Tiram Coklat (Pleurotus cystidiosus) dengan Jamur Tiram Putih (Pleurotus ostreatus) Varietas Gray Oyster Menggunakan Metode Fusi Miselium Monokarion. Bioma. 2017; Vol 6 (2):12.

[5] Maulana E. Panen Jamur Tiap Panduan Lengkap Bisnis dan Budidaya Jamur Tiram. Yogyakarta. Penerbit Dani; 2012

[6] Yuliawati, T. Pasti Untung dari Budidaya Jamur Tiram, Kuping, Merang, Champignon. Agromedia Pustaka; 2016

[7] Maryanti L, Nurmiati, Periadnadi, Kasmawati. Kajian Produktivitas Jamur Tiram Putih (Pleurotus sajor-caju) Di Dataran Tinggi Nagari Sungai Nanam, Alahan Panjang, Kabupaten Solok, Sumatera Barat. Prosiding SEMIRATA. FMIPA Universitas Negeri Jambi; 2017

[8] Suriawiria, U. Budidaya Jamur Tiram. Jakarta. Kanisius; 2002

[9] Andriani S. Pertumbuhan Miselium Bibit F1 Jamur Tiram (Pleurotus ostreatus) Dan Jamur Merang (Volvariella volvacea) Pada Media Biji Padi Dan Biji Nangka. Jurnal. Jurusan Pendidikan Biologi, Universitas Muhammadiyah Surakarta; 2019

[10] Hoa HT, Wang CL. The Effect of Temperature and Nutritional Conditions on Mycelium Growth of Two Oyster Mushrooms (Pleurotus ostreatus and Pleurotus cystidiosus). Mycobiology. 2015; Vol 43 (1):14-23.

[11] Choi IY, Joung GT, Ryu J, Choi YG. Physiological characteristics of Green Mold (Trichoderma spp.). Mycobiology. 2003; 31(139-44).

[12] Kashangura, C. Optimization of The Growth Conditions and Genetic Characterization of Pleurotus species. Department of Biological Science. Faculty of Science. University of Zimbabwe; 2008.

[13] Nurhajadi, MY, Martawijaya EL. Sukses Bisnis Jamur Tiram di Rumah Sendiri. IPB Press. Bogor; 2011

[14] Fu R, Yin C, Liu Y, Ding L. The Influence of Nutrient and Environmental Factors on Mycelium Growth and Conidium of False Smut Villosiclava virens. African Journal of Microbiology Research. 2013; Vol 7:825-33.

[15] Ibrahim R, Jamil AAIM, Hasan SMZ, Arshad AM. Enhancing Growth and Yield of Gray Oyster Mushroom (Pleurotus sajor-caju) Using Different Acoustic Sound Treatments. MATEC Web of Conferences; 2017

[16] Wiardani I. Budidaya Jamur Konsumsi. Jakarta. Penebar Swadaya; 2010.

[17] Hariadi N, Setyobudi L, Nihayati E. Studi Pertumbuhan dan Hasil Produksi Jamur Tiram Putih (Pleurotus ostreatus) pada Media Tumbuh Jerami Padi dan Serbuk Gergaji. Jurnal Produksi Tanaman. 2013; Vol 1 (1):47-53.

[18] Merisya, Nurmiati N, Periadnadi. Pengaruh Pengasaman Air Kelapa dan Air Beras Sebagai Alternatif Pelapukan Media Terhadap Pertumbuhan Jamur Tiram Kelabu (Pleurotus sajor-caju (Fries) Singer). Jurnal Biologi Universitas Andalas. 2014; Vol 3 (3):244-248.

[19] Shah Z, Ashraf M, Ishtiaq M. Comparative Study on Cultivation and Yield Performance of Oyster Mushrooms (Pleurotus ostreatus) on Different substrates. Pakistan Journal of Nutrition. 2004; Vol 3 (3):158-160.

[20] Mondal SR, Rehana MJ, Noman MS, Adhikary SK. Comparative Study on Growth and Yield Performance of Oyster Mushrooms (Pleurotus florida) on Different Substrates. Agrotechnology Discipline. Khulna University. Bangladesh; 2010

[21] Chazali S, Pratiwi PS. Usaha Jamur Tiram Skala Rumah Tangga. Jakarta. Penebar Swadaya; 2009.

[22] Biswas, MK. Microbial Contaminations in Oyster Mushroom (Pleurotus ostreatus) Cultivation Their Management and Role of Meteorological Factors. Proceedings of the 8th International Conference on Mushroom Biology Mushroom Products (ICMBMP8). India; 2014. 567-575.

[23] Purnomo AS, Islami A, Sukesi. Pengaruh Komposisi Ampas Tebu dan Kayu Sengon sebagai Media Pertumbuhan Terhadap Nutrisi Jamur Tiram (Pleurotus ostreatus). Jurnal Sains dan Seni Pomits. 2013; Vol 2 (1):2337-3520.

[24] Muffarihah L. Pengaruh Penambahan Bekatul dan Ampas Tahu Pada Media terhadap Pertumbuhan dan Produksi Jamur Tiram Putih (Pleurotus ostreatus). Skripsi. Jurusan Biologi Fakultas Sains dan Teknologi. UIN Malang; 2009.

[25] Purnamasari E. Produktivitas Jamur Tiram Putih (Pleurotus ostreatus) pada Media Tambahan Limbah Tongkol Jagung (Zea mays L.) Jurnal FKIP Universitas Muhammadiyah Surakarta; 2013

[26] Narwanti EE. Perbedaan Pengaruh Media Sekam Padi dan Serbuk Gergaji Sengon terhadap Berat Basah, Jumlah Tubuh Buah Jamur Tiram Putih dan Efficiency Biology Rate. Skripsi IKIP PGRI. Semarang; 2013

[27] Masefa L, Nurmiati, Periadnadi. Pengaruh Kapur Dolomit Terhadap Pertumbuhan Miselium dan Produksi Jamur Tiram Coklat (Pleurotus cystidiosus O.K Miller). Online Journal of Natural Science. 2016; Vol 5 (1):11-20

[28] Gunawan AW. Usaha Pembibitan Jamur. Jakarta. Penebar Swadaya; 2011

[29] Rahma H. Aktivitas Enzim Media dan Tubuh Buah Serta Aktivitas Antioksidan Tubuh Buah Beberapa Jenis Jamur Tiram (Pleurotus spp.) Melalui Penambahan Kalsit dan Dolomit. Master Thesis. Jurusan Biologi. Universitas Andalas. Padang; 2014

[30] Ashraf SRF, Ali TA. Association of Fungi, Bacteria, and Actinomycetes with Different Compost. Pakistan Journal of Botany. 2007; 39 (6).

[31] Sharma SRS, Kumar, Sharma VP. Disease and Competitor Moulds of Mushrooms and Their Management. National Research Centre for Mushrooms. Indian Council of Agricultural Research. India Technical Bulletin; 2007

[32] Shrestha S, Bhattarai S, Shrestha RK, Shrestha J. Effect of Different Substrate Sterilization Methods on Performance of Oyster Mushrooms (Pleurotus ostreatus). Journal of Agricultural Science. 2021; Vol 32 (1).

[33] Saputra A. Formulasi Komposisi Media Tanam Terhadap Pertumbuhan dan Hasil Jamur Tiram Putih (P. ostreatus) Varietas Gray Oyster (Pleurotus sp.). Skripsi. IKIP PGRI Jember; 2014

[34] Girmiy Z, Gorems W, Birhanu G, Zewdie S. Growth and Yield Performance of Pleurotus ostreatus (Jacq. Fr.) Kumm (Oyster Mushroom) on Different substrates. AMB Expr. 2016; Vol 6(87).

[35] Liang Z, Wu C, Shieh Z, Cheng S. Utilization of Grass Plants for Cultivation of Pleurotus citrinopileatus. International Biodeterior Biodegradation. 2009; Vol 63:509-514.

[36] Obodai M, Sawyer LCB, Johnson PNT. Yield of Seven Strains of Oyster Mushrooms (Pleurotus spp.) Grown on Composted Sawdust of Triplochiton scleroxylon. Tropical Science. 2002; 40:95-99.