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Comparative study on oyster mushroom grown on composited substrate: The effect on yield, growing period and fruiting body size

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Abstract

Cultivation of the oyster mushroom on horse manure and wheat straw compost without nutrient supplementation was investigated. The growing, yield and fruiting body size effects on open trays and substrate bags were determined. Incubation and fruiting period on trays and inoculated bags were compared. The bagged compost yielded higher mushroom growth rate and yield than the tray compost. The fruiting bodies of the mushroom on trays were smaller, pile and thinner as compared to the mushrooms on the bags, which were bigger, fresh and strong. However, it was found that when oyster mushroom are grown on trays, the yield decrease, there is less moisture in the tray and substrate is exposed to heat, the pin head dries as they develop and those that succeed to grown further will grow as thin with a little head due to lack of oxygen. Comparing compost in bags with compost substrate in trays, bags yielded about 20% more mushrooms than trays under the same cultivation conditions. Conversely, the incubation period of compost in bags took longer, as compared to the incubation of compost in trays. Trays gave their first flash 10% earlier than the bags.

Key words: compost, bagged, trays, substrate

Introduction

Mushroom cultivation is a profitable agri-business. Oyster mushrooms are found growing naturally on rotten wood material [1] and with modern technology cultivation of oyster mushroom became an easy practice. Oyster mushroom is cultivated on substrate of agricultural waste [2] such as wheat, rice, maize straws, and corn cobs. Globally, abundant agricultural wastes (AWs) are being generated each day to fulfill the increasing demands of the fast-growing population [3]. Demand for mushroom consumption increased with the shock realization of COVID-19 pandemic worldwide and this is because of the mushroom medicinal purposes. Natural substances such as herbs and mushrooms have previously demonstrated both great antiviral and anti-inflammatory activity [4, 5, 6]. Thus, the possibilities of natural substances as effective treatments against COVID-19 may seem promising [7, 8]. Because of the diversity in Namibian agro ecosystem, not all the regions are able to get agricultural waste to grow oyster mushroom, hence a need to explore other surplus to use in the cultivation of oyster mushroom. A study done by Agrawal et al., [1] cultivated oyster mushroom using biofertilizer that includes certain bacteria such as Azotobacter, Rhizobia and Phosphate solubilizing Bacteria proved to yield better result. In oyster mushroom cultivation, straws supplementation with wheat bran improved yield depending on supplementation and composting conditions [9]. Mageshwaran et al., [10] prepared the bio-enriched compost and cultivation of oyster mushroom using cotton stalks. In determining the effect of chicken manure in sludge biogas as substitute material for bran on oyster mushroom media, the results showed that quality of the oyster mushroom was obtained [11]. A well-known button (*agaricus*) grown commercially in at least 90 countries [12], grows on compost with manure [13, 14, 15]. Information about growing oyster mushroom directly on composited substrate with manure is not available, therefore in this experiment, oyster mushroom was cultivated on horse manure and wheat straws compost without nutrient supplementation in search for additional substrate for oyster growth.

2. Materials and methods

2.1 Mushroom Culture

Tissue cultures of Oyster mushroom were obtained from the mushroom laboratory at the University of Namibia. These cultures were sub-cultured and after mycelia colonization, they were maintained on PDA medium in a fridge at 4°C for further investigation. Wheat straw was mixed with house manure at equal proportion.

2.2 Mushroom spawn

Cleaned and healthy wheat grains were washed in clean water and soaked in tap water overnight

Excess water was drained out the next morning and allowed to dry further in order to obtain a moisture content of 60%. Agricultural lime of 1.5% of the dry weight of the grains was added and the grains were transferred into clean bottles up to 2/3 full and the bottles were closed slightly. Grains in bottles were autoclaved at 121°C for 15 minutes and cooled prior to inoculation. Hands and working area were disinfected by wiping with 70% methylated spirit. The blades were also sterilized with 70% methylated spirit prior to inoculation. About 3 to 4 pieces of culture from the plate (depending on the size of the bottle) were carefully cut and inoculate in the grains. The inoculated bottles were slowly shaken to mix the culture with the grain and replace the cap.

2.3 Compost Preparation

Outdoor composting of wheat straw is mixed with horse manure and then wetted with tap water. The first turning was done on day 4 and 1m high heap was created. Second turning on day 7 and wheat bran was added. The temperature inside the mixture was kept at about 70-75-degree C. Third heap turning was done on day 8 and then on day 10. The compost was transferred into pasteurization tunnel and the second phase of indoor composting started. In order to kill undesirable microbes and to convert ammonia into microbial protein, the mixture was packed in clear plastic bags and pasteurized in a steam drum on fire for 2 hours. The substrate was allowed to cool down to 25-degree C before packed into trays and growing plastic bags of 1.5kg each The weight of the compost on trays were 8kg. The compost was inoculated with the pure spawn under sterile conditions. The inoculated bags were kept in a dark placed until they are fully colonized by the mycelia.

2.4 Incubation period

The spawn bags and trays were placed in dark growing chamber where temperature and relative humidity ranges between 20-25 ºC and 80-85% respectively. The bags were kept vertically on a raised platform while trays placed on top of the shelves in the dark chamber for mycelia colonization of the substrate. After complete colonization of the mushroom bed, the polythene bags were cut sliced, and the trays uncovered. Humidity was maintained by sprinkling water on the floor and walls frequently. After completion of spawn running, pin heads were started appearing within one week on trays and four days later on bags and they both became ready to harvest within another week.

2.5 Harvesting

Harvesting was always done before spraying water. The right stage for picking was judged by the shape and size of fruiting bodies. All the mushrooms were harvested at one time from a bag/tray to allow the next flash of mushrooms starts early. Fruiting bodies were harvested in 5 days after their first appearance. Picking was done by twisting the mushroom gently so that it was pulled out without leaving any stub, and also the surrounding fruiting bodies were not disturbed. After harvesting, lower parts of the stalks/stipes with adhering debris were cut out using a knife. Fresh mushroom was harvested four times at appropriate intervals.

3. Description of the study site

The experimental was conducted at the University of Namibia, mushroom laboratory site. Pure culture and spawn preparation as well as substrate preparation were done on the mushroom laboratory and darkroom respectively. The compost was prepared and managed on the ground interlocked at the back of the mushroom house. The bags and trays fruited in the site fruiting room with dripping irrigation installed.

4. Data collections

The field experiment was conducted during April – October 2021 for observation of growth behavior and yield potential of oyster mushroom grown on compost and packed in bags and trays. Parameters measured during growth behavior investigation (in days) were: spawn run period, initiation of pinhead, first harvesting, second harvesting, third harvesting and fourth harvesting. Growth were measured by total number of fruiting bodies, maximum weight of fruit bodies, minimum weight of fruit bodies as well as the average fruit bodies per packing method in percentages. Lastly, yield potential was measured by yield of first flush (g), yield of second flush (g), yield of third flush (g), yield of fourth flush (g), total yield (g) and biological efficiency (%).

The biological efficiency (BE) was calculated by given formula [16]

Biological efficiency (BE) = fresh weight of mushrooms dry weight of the substrate x 100

5. Results

5.1 Growth behavior of oyster species in different packing methods

The growth behavior of fruiting bodies like spawn run period, pin head initiation, days for first harvesting, second harvesting, third harvesting and fourth harvesting were recorded and results were shown in Table 1.Results showed that spawn run on trays colonized faster, taking 18.00 days as compared to bagged spawn run which were completely inhabited in 21 days. Time required for initiation of pin head in both trays and bagged were 18.00 and 21:00 respectively. Data presented in the table showed that the mushroom pin head was first initiated on substrates packed in the trays in 18 days while in substrate packed in bags pin head was initiated in 21 days as indicated in Table 1. Four flushes were harvested during this crop period. The result in respect to harvesting of first flush was 24:00 for trays and 26:00 days for bagged. After harvesting of first flush, the second flush took 24:00 and 26:0 0 for trays and bagged days' time for harvesting respectively. The data pertaining to the harvesting of third flush showed that substrate on tray took minimum time 40:00 days and maximum time was taken substrate in bags 48.00 days. In fourth flush maximum time (56:00) was taken by bags and minimum cropping period was recorded in trays where it took 51:00 day.

Table1. Comparison of different packing methods of oyster for growth behavior in days after spawning

Method of substrate Packing	Oyster growth period in days after spawning					
	1st spawn run	1st Pinhead	1st harvest	2nd harvest	3rd harvest	4th harvest
Bagged	17.00	21.00	26.00	38.00	45.00	56.00
Trays	17.00	18.00	24.00	35.00	40.00	51.00

Values are expressed as average of three replications

5.2 Comparative study on growth parameters of trays and bags packed substrates.

Number of fruiting body was found significant among different substrate packing methods of oyster mushroom. Maximum number of fruiting bodies were obtained in substrate on trays (32:00) as compared to substrate bagged (28:00). Yield of mushroom was mainly dependent on number of fruit bodies and yields were further declined where decline in the number of fruit bodies (Table: 2). The result indicated that the highest weight of fruiting body was produced by bagged substrates (10.20g) with minimum weight of fruiting body observed in substrates on trays (5:80g). Weight of fruiting body was depending on size of sporophores of mushrooms.

Table 2. Comparison of different packing methods of oyster for growth parameter

Method of substrate packing	Total number of fruiting body	Maximum weight of fruiting body (g)	Minimum weight of fruiting body (g)	Average weight of fruiting body (%)
Bagged	28.00	10.20	2.80	6.50
Trays	32.00	5.80	1.40	3.6

Values are expressed as average of three replications

5.3 Yield potential of mushroom

There was a significant result obtained for the yield pattern of different substrate packing methods of oyster mushrooms. Total four flushes were harvested during the trial and observation of the yield was recorded in each flush. Mushroom yield was calculated by using fresh weight. A continuous reduction in yield was recorded during harvest of next flush. The maximum yield of oyster mushroom in first flush was obtained substrate in bags (18.20g) while minimum yield was recorded on substrates in trays (14.0g). Similarly in the second flush, highest yield was obtained in bagged substrates (15.20g) whereas lowest yield was recorded on substrates in trays

(12.00g). Table: 3 showed that in the third flush maximum yield was recorded in bagged substrates (13.00g) as compared to yield from substrates in trays. In the fourth flush maximum yield was obtained in bagged substrates (8.00g) and minimum yield was recorded substrates in trays (4.10g). Substrates that were in bags was better in performance, yielded 54.3g of dry wheat straw substrate while least yield 36.6g was acquired from substrates in trays. Biological efficiency was recorded for both bagged and substrate in trays of oyster mushroom. The highest biological efficiency was recorded from bagged substrates (54%). Minimum biological efficiency was recorded in substrates in trays (37%)

Table 3. Comparison of different packing methods of oyster for yield potential

Method of substrate packing	1st flush (g)	2nd flush (g)	3rd flush (g)	4th flush (g)	Total Yield (g)	Biological efficiency (%)
Bagged	18.20	15.10	13.00	8.00	54.3	54
Trays	14.00	12.00	6.50	4.10	36.6	37

Values are expressed as average of three replications

6. Discussion

Presented study showed that the spawn run was very fast to colonize substrate packed on trays as compared to bagged substrates which had taken maximum time for spawn run. Similarly in substrate packed on trays, pin head formation and harvesting period was earlier as compared to bagged substrates. Biological efficiency was high in bagged substrates while the total number of fruiting body was highest in substrate packed on trays. Similarly, sporophores parameters and yield was highest in bagged substrates. Our finding have similarities with the study results of Holkar and Chandra [17], who compared five Pleurotus species in perspective of actual time required for every development stage viz., spawn run period, number of days required for beginning of pin heads of sporophores, average weight of fruiting bodies in the entire harvesting and overall yield. The present study proved that the oyster mushroom can be cultivated not only on agricultural waste but also on composted straws with horse manure. Mycelium colonized the composited substrate similarly to non-composted substrate used in growing oyster mushroom and the time that it took to full colonize both trays and bags were comparable. The performance of compost on trays was affected by light, temperature and oxygen and that led to yield reduction. With the scarcity of agricultural waste in some regions of Namibia, this study recommend an appropriate quantity of horse manure be used in the cultivation of oyster mushroom in Namibia

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Biography

Fimanekeni Ndaitavela Shivute received her Master in Plant Genetics and Breeding from South China Agricultural University, China in 2013. She is currently on her final year PhD, at the same University majoring in Plant Genetics and Breeding. **Research interests** in improving the livelihood of rural & urban communities through mushroom and rice cultivation trainings, ensuring food security, create employment and health benefit from the edible & medicinal mushroom in the country.