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Variables Influencing The Growth Of Golden Oyster Mushrooms

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ABSTRACT

Background and Objective: Different components in the substrate affect the growth, yield of golden oyster mushrooms. Our objective is to compare the growth and yield difference between three substrates and to know which is the ideal fit substrate.

Methods:When it comes to the cultivation of yellow/golden oyster mushrooms, we have tried the use of three substrates (simple/mixed). Each substrate has itseffect on the overall yield. A comparative study is made on the yield of golden oyster mushrooms with a few set parameters like temperature, humidity, moisture, lighting and ventilation (environment).

Findings:Pasteurised, moist straws and straws combined with residues of tea dust prove to an effective substratecompared to sawdust combined with residual green tea dust. The overall yield of yellow oyster mushrooms was estimated to be roughly 1.3-1.5 kg in bags while not even a three-fourth yield was obtained when grown in trays. Blue light-emitting diodes with increasing exposure time after the first fourteen days of bags/trays in darkness have helped in the development of fruiting bodies. Inthe case of the spawn run in trays, the substrate utilization has been much faster and the yield getting affected, blue lights contributed to least substrate utility. Ventilation plays a very important especially during the fruiting stage as there is an increased need for oxygen (O_2). The temperature of 25-29°C with moisture in the air of about 60-75% has been ideal for the yield of yellow oyster mushrooms.

Novelty: The growth and yield of golden oyster mushrooms are greatly influenced by certain variables including surface area of the substrates, temperature, moisture, use of light-emitting diodes and ventilation. These will lay an outline to the interest of golden oyster mushroom cultivation which has extravagant medicinal properties.

Keywords: Illumination, moisture, mycelial growth,Pleurotuscitrinopileatus, substrate, temperature.

1. INTRODUCTION

Pleurotus species of mushrooms are saprotrophs (decomposers) which can best grow in a temperate zone and stands as the third-largest edible species to be cultivated worldwide [1-3]. Various agro-wastes can be used in the cultivation of Pleurotuscitrinopileatus but appropriate preparation of the substrates alone maximizes the yield of the mushrooms [4-6].Cultivation of P. citrinopileatus is considered to be simple, cost-effective and an environmentally friendly technology for the utilization of agronomical waste.

Microorganisms need a substrate to flourish in growth and when this substrate is an organic compound and if it is moistened then the nutritive content of the substrate will help microorganisms to breed by utilizing the accumulated proteins and other useful compounds. Pasteurised substrate is utilized by the growing mushrooms as most of the contaminating microorganisms are killed upon exposure to a certain amount of heat. This study presents an assessment of P. citrinopileatus mushroom productivity on different substrate formulations of:

1. Pasteurised and moist paddy straws
2. Pasteurised, moist straws mixed with tea dust and
3. Raw sawdust mixed with green tea dust.

Apart from the substrate formulation, substrate quantity and shelf position of the mushrooms in plastic trays and breathable mushroom bags also have their effects on the yield of P. citrinopleatus. The study is similar to an experiment conducted in Harare, Zimbabwe on the yield of oyster mushroom (P. sajor-caju) using plastic tray culture [7]. Temperature, moisture and lighting are other aspects that affect mushroom productivity/ yield.

Golden Oyster Mushrooms (GOM) otherwise known as yellow oyster mushrooms by local people is because of the varying amount of carotenoids present. The Pleurotus mushrooms are considered a good source of proteins, vitamins and minerals, some carbohydrates and one percent or less than 1% of fat. Apart from being nutritive, it is also of great medicinal importance.

A few drugs taken by diabetic patients harm the kidney functions (especially Type 2 diabetic patients) while some have a deleterious effect on liver functions when administered in long run. More importantly, many chemotherapeutic drugs have notable side effects like paralysing the immune system. There are other major lifestyle diseases like heart disease, obesity, stroke, respiratory diseases, Alzheimer's, Cirrhosis and many more. World Health Organization (WHO) says "The cost of non-communicable diseases to the Indian economy in the period 2012-30 is $6.16 trillion". The Only way to reduce the toxic economic burden on an individual is by adopting a healthy lifestyle. Going green, accumulating all the resources that supplement one's health and micro-farming at home are ways to adopt a healthy lifestyle and avoids the toxics of exaggerated advertisements.

GOM is an easy-to-grow mushroom variety and is highly preferred by home-based cultivators. These mushrooms are used by many drug industries because they have vitamin B (B1 and B2), folic acids, more copper and zinc, several antioxidants, carotenoids, the gills when exposed to sunlight turns the ergosterol to Vitamin D, so there is a lot of vitamin D. There are medicinal compounds like beta-glucan,

poly-saccharides, and there are several immuno-modulating compounds that recognize the tumor cells and educate the immune system to perform a higher level of function in eliminating the viral loads and other pathogens. These mushrooms are heavily studied for helping the body stop the reproduction of viral cells or retroviral cells creating an opportunity for them to work with the immune system in the perspective of clearing and cleaning the body.

1. MATERIALS AND METHODS

Paddy straws (Dry), raw sawdust, tea dust, green tea dust were used solely or mixed and used as substrates 1, 2 and 3. Twenty-five bags [size: 20 × 40 cm], plastic trays [Size: 21 × 29 × 5.5 cm], Temperature humidity digital clock, P. citrinopileatus spawns, mesh stands, clean cloth, water, water sprayer, scissors, needles and rubber bands are the dire requirements for the experiments on mushroom cultivation. For mushroom cultivation to happen without intervention, providing a sterile space with an air conditioner has been our priority.

1.1. Preparation of Substrate

Soaking and Pasteurization are important steps in preparing a substrate for mushroom cultivation. The paddy straws which are chopped down to 4-10 cm and sawdust obtained from the trees are used as substrate with or without tea/green tea dust is studied here.

Soaking and Pasteurization of straws: About 1.5 kg of chopped dry straws were soaked in a barrel of water overnight. No further chemicals were added to the soaked straws. Soaking straws removed dust, insects, water-soluble carbohydrates and potassium a water-soluble minerals/inorganic fertilizer. Microbes/ molds in straws are eliminated upon pasteurization (straws are boiled for 30 minutes at 120-160˚C.

Soaking and Pasteurization of sawdust: About 1 kg of sawdust was soaked in water for 72 h and boiled for 2 h at 90-100˚C [8].Sawdust contains a high proportion of lignin and/or substance(s) which inhibits mushroom fungus growth. In this context, prolonged water soaking pretreatment with frequent water change (every 24 hours) may reduce such inhibitors and enhances the productivity of mushrooms grown on sawdust substrate [9].

Once pasteurized the substrates' wet weight was measured.

1 kg of straws (dry weight) = 4 kg of Straws (wet weight)

1 kg of sawdust (dry weight) = 2 kg of sawdust (wet weight).

1.2. Inoculation of Spawns in the Substrate

The pasteurised moist straws and sawdust were packed in different 20 × 40 cm breathable polythene bags and trays respectively. Golden oyster mushroom spawns were inoculated at a rate of 5% (based on the wet mass of the substrate straws and sawdust staked/packed in polythene bags and trays). Once the substrate is inoculated

with spawns, it is tightly packed and sealed. Holes are punched on the surface of the bags to exchange clean air with growing mycelium.

1.3. Culture Conditions for Spawn Running and Fruiting Bodies Formation

Once the inoculated substrate was incubated for spawn run at 24°-26°C in darkness, mycelial growth/colonization begins. It takes 7-8 days for the bags and trays to be completely covered with white patches of mycelium. Once the trays and bags were covered with white patches together the room was lighted 12 h/day and the temperature was maintained between 23°-27°C. For homogenous ventilation, fans were run for 2-3 h/day during incubation for basidiocarp formation.Bags and trays were monitored for moisture check and water is sprayed 2-3 times a day to maintain moisture if lost during the whole cropping period. Pinhead was observed by the third week followed by the development of young mushroom fruiting bodies. These fruiting bodies were harvested once they are mature enough i.e., mostly one week after the observation of primordial buds/pinheads when the cap turned a little darker and started curling.

1.4. Bag vs. Tray:

We used eight bags and trays for each substrate, which makes 24 bags and trays.

2. RESULTS

2.1. Substrate 1: Pasteurised and moist paddy straws

2.1.1. Spawn run in bags vs. trays

The 1.5 kg of the substrate was inoculated with 15 g of spawns and packed in a breathable polythene bag. Holes were punched and the bag was kept in an acetone fumigated room at a temperature between 23°-27°C in complete darkness. Mycelial colonies increased in diameter. As the colonization increases, the moisture content is lost. Henceforth, water was sprayed 2-3 times a day. By the second week, the colonies have spread (white web) throughout the bags and trays. Moisture is continuously monitored, the temperature was maintained between 25°-29°C with 12 h-42 h exposure to lighting. In trays, the mycelial colonies covered the substrate much faster compared to that in the bags.

The amount of substrate and spawns added to trays and bags were the same whereas the space it occupies varies therefore the pressure exerted in bags was more compared to that of trays explaining the differences in time for the mycelial colonization.

2.1.2. Pinhead formation, Fruiting body formation and Ageing

Pinheads are produced both in bags during the end of the second week or starting of the third week. Two to three days after pinheads appeared with lighting for upto 12-24 h a day, temperature about 24°-28°C and moisture of 75-70% sufficed the growth of young fruiting bodies (stipe and pileus(cap) with gills). Once the

growth is complete, i.e., the cap darkens and curls, gills were decurrent and the stipe appeared thicker. The length of the stipe ranges from 4.5-14.0 cm, the pileus diameter ranges about 5.5-25.0 cm when the thickness of the pileus ranges about 0.5-0.8 cm.

The time taken for the pinheads and mushroom fruiting bodies formation in trays is more or less the same given similar parameters such as lighting, temperature and moisture content. The difference was observed in the Stipe length ranging between 2.0-11.5 cm, the pileus diameter ranges about 4.0-8.6 cm when the thickness of pileus ranged 0.3-0-6 cm. The aging of the mushrooms is quiet earlier in trays than in bags. The reason behind this was the loss of moisture in the substrate despite maintaining high relative humidity inside the culture room. Moisture in the tray was lost as it was left open to facilitate exchange of clean air which was the need of the hour to enhance the primordial growth and budding of mushrooms.

2.1.3. Harvest and Yield

Yellow oyster mushrooms do not essentially need a casing to supplement their growth. GOM harvest occurred three-four after the formation of young fruiting bodies. The number of flushes per bag/tray depends on the substrate nutrition available/remaining. Nearly 750-800 g of the mushrooms were harvested from each bag while 350-510 g of the mushroom were harvested from each tray during the first flush. During the second flush, 300-450 g of mushrooms were harvested from the bag while 150-200 g of mushrooms were harvested from the tray.

2.2. Substrate 2: Pasteurised, moist straws mixed with tea dust

Fermented tea dust was used as a casing material, a moist layer that was put on top of the substrate with mycelium, before exposing the substrate to fruiting conditions. The fermented tea dust locked the moisture content in the substrate and provided added nutrition for the fruiting bodies. For mature mushrooms, it acts as a water reserve. About 150 g of the fermented tea dust was added to both bag and tray equally.

The harvest was more or less the same from bag and tray but the fruiting bodies appeared were tender than those harvested from the Substrate 1. The only difference between the substrates was the size of the mushrooms. The mushrooms were substantially different in the size of the fruiting body.

The Pileus diameter was about 4.5-18.5 cm, pileus thickness around 0.3-0.7 cm. The length of the stipe was about 2.5-12.0 cm. The stipe was juicer compared to the stipe of the mushrooms harvested from Substrate 1. This implies oyster mushrooms grow despite the absence of a casing medium but the casing makes the mushrooms much more delicate and juicer.

2.3. Substrate 3: Raw sawdust mixed with green tea dust

Pretreatment of 2 kg sawdust [hardwood acacia] (72 h of soaking with change in water every 24 h and 2 h of boiling) has indeed caused mycelial ramification by the end of the second week. About 150 g of green tea waste was added to lock moisture as a casing medium and then after two weeks of incubation in the darkness of temperature ranging 24°-27°C with the moisture content of 75-80%. Once the bag and tray were entirely covered with a mycelial mat, the room was lit for 24 h/day and moisture content was maintained for the primordia to develop. After 16 days of incubation, primordia developed and with another 8-10 days of incubation so did the fruiting bodies emerge.

The time taken for the complete growth and harvest is more compared to that of Substrates 1 and 2. Biodegradation of substrate by the fungal growth is substantially lower with sawdust because of the presence of organic compounds.

The maximum yield obtained was about 272.8 g after the first flush when less than 40 g was harvested after the second flush. The fruiting body harvested from the substrate had a pileus thickness ranging between 0.1-0.3 cm, with a pileus diameter ranging between 4.5-16.5 cm, stipe length ranged about 5-8.5 cm. This implies the fact that substrate 3 lacked providing sufficient nutrients for GOM to flourish.

2.4. Lighting and its effect on Growth of GOM's

LED lights (Blue) are effective for mushroom cultivation but the time of exposure and stage of exposure plays an important role in the growth of GOM's [10]. When spawns are running through the substrate, light exposure can delay primordia formation [11].If the light exposure is slowly increased each day or two after the complete spawn run, then the pinheads start early and the fruit bodies formed are fragile and fresh.

2.5. Ventilation and its effect on GOM's

Air circulation is very important and it has a direct effect on spawn runs. Without a proper ventilation system, heat exchange will not happen and it becomes a factor for inhibiting spawn run. With warmer air, humidity builds up within the bags that mycelial colonization is enhanced. 65-75% humidity enhanced the yield of GOM. Distributing cooler air from the air conditioner reduced humidity within the bags. Pores in mushroom bags enhance air circulation and release excess moisture from it [12].

3. DISCUSSION

Substrate 1-3 shows the number of mycelial colonies formed between day 0-20 during the incubation period (Fig. 1). The diameter range of the mycelial colonies in the substrates 1 and 2 developed faster, steadily compared to the third substrate (Fig 2). The size of the fruiting bodies was comparatively bigger in the second substrate rather than the substrates 1 and 3 (Fig 3). Henceforth, after the comparative study made, Substrate 2 was considered most suitable for the cultivation of mushrooms given exposure to blue LED light at a

temperature 27°C. The yield was more, the fruitbodies were tender and fresh and comparatively more in substrates 1 and 2 rather than the third substrate. Thus with simple agro-waste cultivation of GOM which is of excellent flavors and medicinal values are harvested in 28-30 days.

3.1. Effect of different substrates used in oyster mushroom cultivation

Substrates play a vital role when it comes to oyster mushroom yield and biological efficiency. The final results closely match with the study of Nasiret al. who found that acacia sawdust is best compared to other sawdusts of different woods like mango, siambal, kail and mixed sawdust [13]. The maximum yield from the sawdust was likely 282.2 g with a biological efficiencyof 70.56%. The results coincide with the study made by Adewoyin and Ayandele as the maximum yield of 361.30 g was harvested. This brings us back to comparing it with the other two substrates [2].

The use of paddy rice straw as a substrate (1 and 2) has given a greater yield compared to the third substrate which includes sawdust. The data corresponds to the experiment performed by Yang, Gao and Wan as the biological yield comparatively larger with the use of rice and wheat straws supplemented with cottonseed hull [14].

The pileus length, diameter, stipe length, morphological quality and yield of oyster mushrooms depend on factors like ventilation and humidity. With indoor humidity, temperature and moisture in the environment, the above has been achieved.The fact correlates with Islam and his colleagues, where the indoor cultivation models [ventilation and humidifying system] hva proved to have an impelling effect on grey oyster mushroom cultivation [15].

3.2. Blue lighting used in oyster mushroom production

The golden oyster mycelial development, primordial differentiation and fruiting body development were greatly influenced by blue lighting. Blue lighting enhanced the pathway activation of glycolysis and pentose phosphate which improved the growth rate of the white oyster mushroom and their yield [10, 11, 16].

3.3. Bags vs. Trays

The substrates 1-3 inoculated with mushroom spawns in bags had a greater yield compared to the trays. This was because of the effect of substrate depth and density. The depth and the density of substrate packed in bags were comparatively more than the trays we used. Therefore substrate utility influenced the yield. Our results contradict the experimental studies performed by McCanna in Agaricusbisporousmushroom cultivation. They optimised the compost depth and density in the plastic bag and tray system and provided a conclusion that yield was lowest when both density and depth of the compost (substrate) were increased. So the depth

was standardised and the density was altered to compare the difference in the yield. To their surprise, the yield from trays was equally comparable to that of the loosely filled low bags [17].

4. CONCLUSION

This study emphasis on the variables and their importance in mushroom development. Without substrate in bags or trays, the importance of the substrate thickness and its need would have never been appreciated. Blue lights reduced the substrate utilization and helped with the yield when ventilation, temperature and moisture supported the fruiting body formation. Fruiting bodies were not properly developed and sometimes stopped with dried pinheads when one of the variables was compromised.

CONFLICT OF INTEREST

There is no conflicts of interest.

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Figures:

Figure 1: Number of mycelial colonies formed during incubation period.

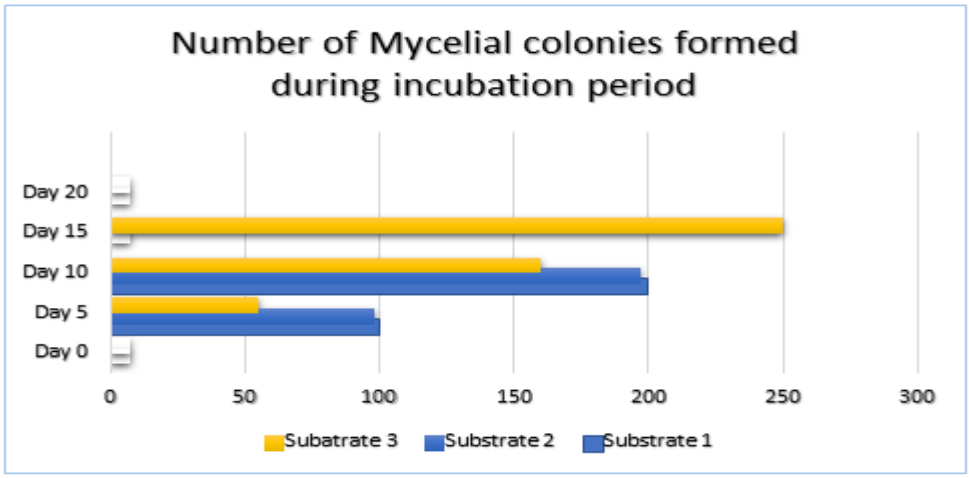


Figure 2: Diameter range of mycelial colonies in different substrate types.

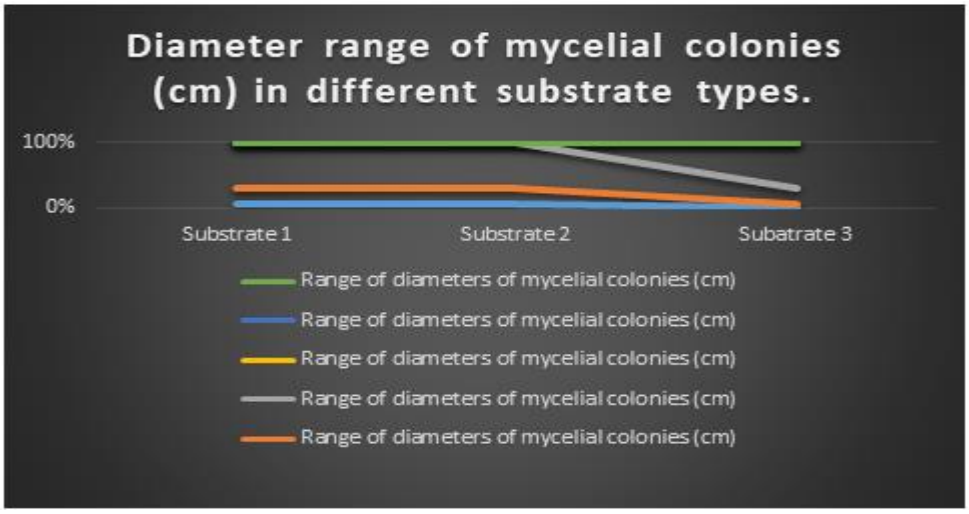
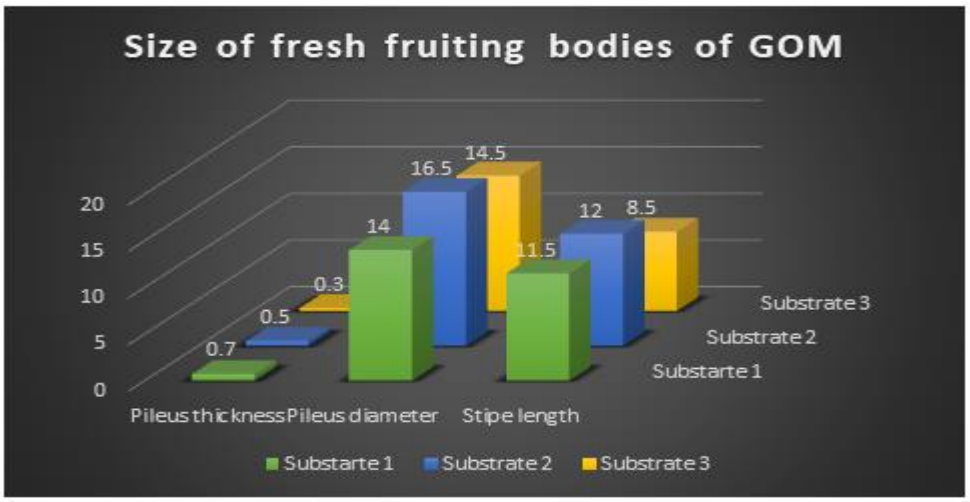


Figure 3: Size of fresh fruiting bodies of GOM.


Size of fresh fruiting bodies of GOM
20
15
10
5
0
0.7
0.5
0.3
14
16.5
14.5
11.5
12
8.5
Substrate 3
Substrate 2
Substarte 1
Pileus thickness
Pileus diameter
Stipe length
Substarte 1
Substrate 2
Substrate 3