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Analogical study on Growth Performance of Oyster Mushroom (*Pleurotus sajor-caju*) using Lignocellulosic By-products of Different Substrate Combinations

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Abstract
Mushrooms are the members of fungi kingdom. The study conducted on growth, yield performance of Pleurotus sajor - caju describes the selection of suitable combination taken from lignocellulosic by-products. Cultivation of mushroom on different lignocellulosic wastes like paddy straw, sugarcane bagasse, sawdust and spent coffee ground is a bioconversion process and also an additional nutrient for the growth of Oyster mushroom. Spawn was prepared from two different types of grains, sorghum and wheat. Among the two, wheat reported a faster mycelial growth compared to sorghum grains. Besides the cultivation in four different substrates sugarcane bagasse's yields higher and also faster growth in case of mycelial colonization, pinhead formation and harvest. Sugarcane bagasse's was followed by paddy straw and reported least in sawdust and spent coffee ground. The biological yield was higher in sugarcane bagasse (87.6%), followed by paddy straw (60%), and followed by sawdust (51.1%) and least in spent coffee ground (44.8%). Temperature also affects the growth of oyster mushroom.

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INTRODUCTION

Fungi, are group of spores producing, achlorophyllous organisms belonging to the class basidiomycetes. The genus *Pleurotus* (Oyster mushroom), a macro fungus and an edible fungus which accumulates its food by secreting degradative enzymes (Mahalakshmi *et al.*, 2020). They can be cultivated in varied climatic conditions especially temperate forest of tropical and sub- tropical climates. Oyster mushroom (*Pleurotus sajor – caju*) is commonly called as 'Dhingri' and it is also often called as boneless vegetable (Alka Singh *et al.*, 2018).

Oyster mushroom constitute many nutritious components including proteins, amino acids, vitamins, minerals (Caglarimak, 2007). Oyster

mushroom are commonly cultivated, as they require a short growth period, utilization of less water compared to other crops, low-cost eco-friendly cultivation technology. They have the ability to utilize the agricultural by-products containing carbon based organic matter which includes cellulose, lignin, hemicellulose as a main constituent for their nourishment, since they have a saprophytic mode of nutrition. As mushroom are spore bearing fungi, they are reproduced by asexual reproducing unit called spore. The fruiting body of this mushroom contain a stem (stipe), cap (pileus), hymenium (lamella) and spores are present underside of the cap. The mushroom fruiting body is rarely attacked by diseases and insects and it can withstand these factors.

Oyster mushroom cultivation has increased recently due to the availability of various kinds of woods, agricultural wastes such as rice husk, paddy straw, sugarcane bagasse and other include cotton waste, duck weed, cardboard, tea leaves waste, wheat straw, corn cobs, damp soil etc. (Arowosage *et al.,* 2017). The main reason behind using these substrates are, they are easily available and accessible at minimal costs as they are considered as wastes. The substrates from the wastes are helpful in both the ways, one it serves as a very good nutrient medium for the growth of mushroom, and the other is that, using these agricultural wastes is a bioconversion and reduce environmental pollution as these wastes are burnt after the harvest period and hazardous to nature. These agricultural wastes are in abundant especially in Tamilnadu state were people mostly rely on agriculture for their livelihood (Ponmurugan *et al.,* 2007). These wastes act as a very good soil conditioner after mushroom harvest (Nasir Ahmed Khan *et al.,* 2021).

The optimum factors responsible for oyster mushroom growth includes pH, temperature, relative humidity, light, rainfall and carbon dioxide. Oyster mushroom is taken as a healthy dietary food as it has low calorific value and higher consumption of mushroom has been associated with lower risk of breast cancer. They cure tuberculosis (night sweating), it provides relief for hyper activity and constipation, cures jaundice. Therapeutic properties that mushroom possess include, antibacterial, anticancer, antioxidant, immune stimulatory, antiplatelet system antitumor activity (Yashvant Patel, 2012). They are good for diabetic patients and for expecting mothers. Mushroom has been recently identified as an inhibitory of HIV virus of AIDS disease in USA and Japan. The present study aims to determine the effect on the growth of oyster mushroom on using four different substrate combinations.

MATERIALS AND METHODS

Study Area (Plate- 1 and 2)

The study was carried out at two places, Nirmala College for Women, Coimbatore and in Malaikovil, Salem to compare the growth rate in spite of the weather, temperature etc.

Study Area 1

Study Area 2

Table 1: Showing Substrate Combinations used for Mushroom Cultivation

S. No	Substrate Type	Substrate	Composition
1.	Agricultural waste	Paddy straw (S1)	Paddy straw (100%)
2.	Agro industrial waste	Sugarcane bagasse (S2)	Sugarcane Bagasse (80) %: Paddy straw (20%)
3.	Wood waste	Sawdust (S3)	Sawdust: Rice bran: Gram flour: $CaCO_3$ (80%) (10%) (7%) (3%)
4.	Domestic waste	Spent Coffee ground (S4)	Coffee ground (80%): Paddy straw (20%)

Spawn

The spawn is prepared from direct tissue culture method on two types of grains, sorghum and wheat. For the cultivation of oyster mushroom (*P. sajor- caju)* four different types of substrates were used, paddy straw, sugarcane bagasse, sawdust, spent coffee ground.

Figure 1: Different types of substrates used

Substrate sterilization

Paddy straw was sterilized by hot water treatment. Sugarcane bagasse was sterilized by chemical treatment. Sawdust and spent coffee ground were sterilized by steam pasteurization method.

Spawning

The sterilized substrates cooled down and spawned in a polypropylene bag (35×50cm). Substrate 1 and 2 (paddy straw and sugarcane bagasse) were spawned by layer by layer especially in the corners of the bag and tied with a thread. Substrate 3 and 4 (Sawdust and spent coffee grounds) were opened after pasteurization process and the spawns are spawned in the upper layer of the substrates in corners and tied at the top of the bag. Small holes were made in all the spawned bags for good aeration as mushroom requires oxygen for growth and also the emergence of fruit bodies takes place through the holes made. The spawned bags were hanged in a dark room with optimum temperature of 20-25^{o}C and 80% relative humidity. The ground surface of the room is always kept moist by sprinkling or pouring water for a good growth of mushroom and to keep the place cool.

Cropping and Harvesting

After pinheads arise, the complete growth of mushroom takes place within 2 days. The mushrooms are plucked by twisting it and pulled along with the stalk. The harvesting is done on each flush. The mushrooms are weighed and its size was measured. The mushroom are then cleaned and stored by packaging.

Data collected

After harvesting the mushroom, data were collected from all the substrates including the yield parameters like fresh weight of mushroom, dry weight of substrate, number of pinheads,

biological efficiency. And growth parameters like stipe length (cm), cap diameter (cm) were also recorded after each harvest.

Yield

After the harvesting period, data were collected to calculate the total yield in each bag, (i.e., fruit bodies of mushroom) and also to estimate the biological yield using the fresh mushrooms.

$$\text{Evaluation of biological efficiency (B.E)} = \frac{\text{Fresh weight of harvested mushroom (gm)} \times 100\%}{\text{Weight of Dry substrate (gm)}}$$

RESULTS AND DISCUSSION

Spawn Run

Among the two grains used for spawn preparation, wheat revealed a faster mycelium colonization, which took 14 days to complete, while sorghum grains were partially completed colonization in 14 days.

Figure 2: Spawn run in wheat

Effect of Supplements used

In this study, along with substrates, few supplements were added to enhance the growth and nutrient source on the growing mushroom. Rice bran and gram flour has been used as supplementary items were rice bran constitute protein, starch, cellulose and lignin. And gram flour contains a higher proportion of carbohydrates, protein and moisture content as reported in Neupane *et al.*, (2018).

Mycelium running in substrates

The mycelium colonization differs from each substrate combination as illustrated in Table 2. In paddy straw, mycelium colonization took 16 days to complete. In sugarcane bagasse, it took 14 days to complete mycelium running and it has also been recorded as the substrate which took a smaller number of days to complete the colonization. Sawdust took 20 days to complete and spent coffee grounds were recorded the least with 30 days. Mushroom growth renders when the lignin content is high as they are sometimes not easily degradable and take more time to get utilized by the mushroom mycelium. Sawdust and coffee waste are rich in lignin content than other components; hence it took more time for fruiting compared to sugarcane bagasse and paddy straw. As it was reported in Arushdeep Sidana and Uman Farooq, (2014).

Table 2: Showing growth parameters and B.E on different substrates

S. No	Substrate	Mycelium colonization	Pinhead formation	Harvest	Biological Efficiency (B.E)
1	Paddy straw	16	18	20	60
2	**Sugarcane bagasse**	**14**	**16**	**18**	**87.66**
3	Sawdust	20	19	22	51.15
4	Coffee grounds	30	34	36	44.87
5	Mean	20±6.164	21.75±7.154	24±7.071	60.92±16.347

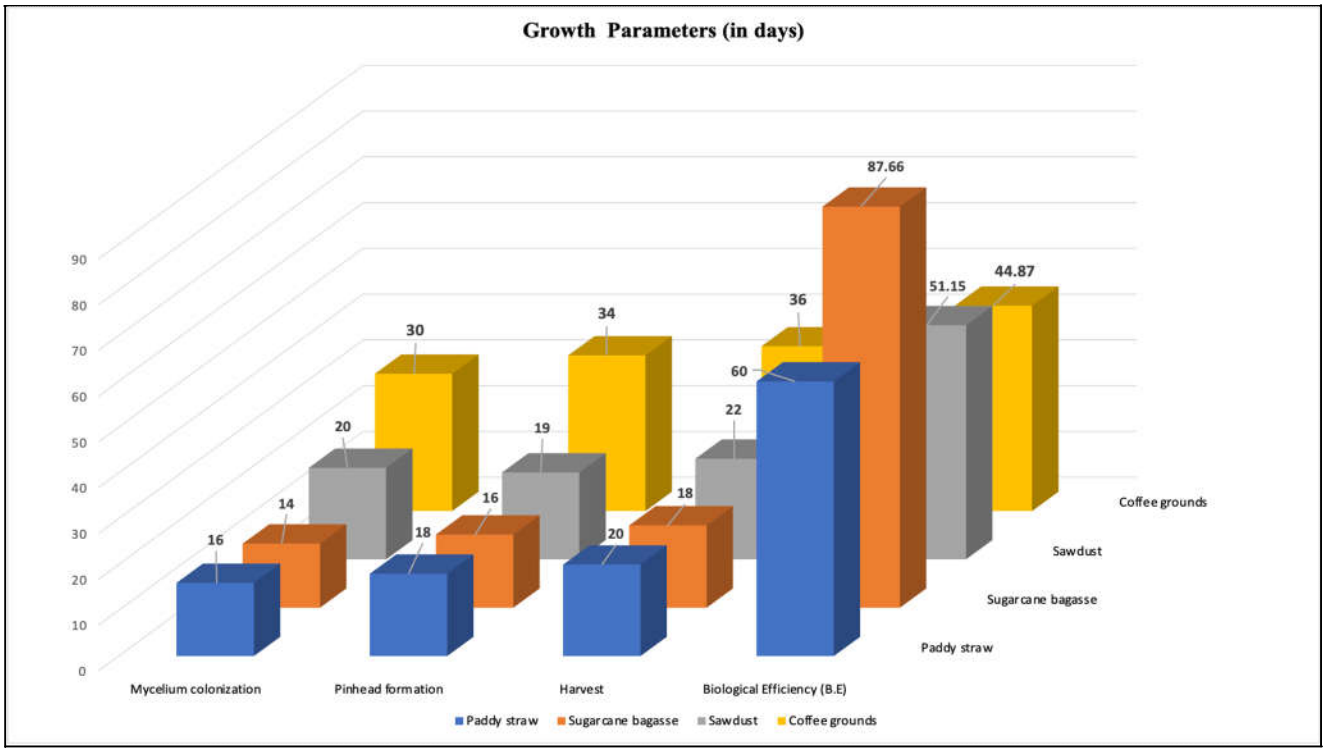

Figure 3: Showing growth in days

Suitable sterilization

Sugarcane bagasse exhibited an enhanced yield and earlier mycelium formation as it was sterilized by chemical treatment followed by paddy straw through hot water treatment. Sawdust and spent coffee ground shows slower growth and less yield which was sterilized by steam pasteurization method. Similar results were resulted in Kathiravan, and Krishnakumari, (2020) were the effect substrate sterilization influence the growth of Oyster mushroom.

Initiation of Pinhead

Pinheads starts to arise in 16 days in sugarcane bagasse, followed by 18 days in paddy straw, followed by sawdust in 19 days and recorded least in spent coffee ground, which took maximum number of days of about 34 days to initiate. Sugarcane consists of two parts, the inner pith, rich in sucrose content and the outer

rind, consisting of lignocellulosic fiber, because of which gives a worthy result. This was experienced by Nithyatharani and Kavitha, 2018, who reported that, oyster mushroom grows faster in substance rich in sugar content than in other lignin based wastes. As sugar is the sucrose, which provides a suitable medium for the growth of oyster mushroom. Also, they possess a very good water holding capacity and gives an appropriate condition to grow.

Figure 4: Growth of oyster mushroom in different substrates

Growth Parameters

The growth parameters like cap diameter, stipe length was measured. The cap diameter was measured higher in sawdust (8.5cm), followed by sugarcane bagasse (8.2cm), paddy straw (7cm) and least in spent coffee ground (5cm). The length of the stipe was measured higher in paddy straw (9cm) followed by sugarcane bagasse (7cm), sawdust (5cm) and observed least in spent coffee ground (4cm).

Table 3: Showing growth parameters on different substrates

S. No	Substrate	CD	ST	Cap colour
1	Paddy straw	7cm	9cm	Pure white
2	Sugarcane bagasse	8.2cm	7cm	Pure white
3	Saw dust	8.5cm	5cm	Pure white
4	Coffee ground	5cm	4cm	Pure white

Period taken for harvesting

The harvesting time varies for each substrate based on the mycelium growth in the mushroom bag and the optimum factors acting on it. The minimum harvesting days was taken in sugarcane bagasse, followed by paddy straw, sawdust and maximum in spent coffee grounds.

Biological yield

The biological efficiency was calculated to find out the appropriate and cost-effective substrate combination for oyster mushroom cultivation. Biological efficiency (B.E) was recorded higher in sugarcane bagasse and least in spent coffee ground.

Temperature

Relating the growth condition chiefly the temperature effect in two different places took for this study, Coimbatore (22°C) suited best than Salem where the temperature is little higher. Hence, oyster mushroom (*Pleurotus sajor-caju*) grows better in places with the temperature ranging 20°-25°C.

Table 4: Showing the Growth and Weight of the selected substrates

S. No.	Substrate	Growth in days	Weight
1	Paddy straw	20	180
2	Sugarcane bagasse	18	263
3	Sawdust	22	102.3
4	Spent coffee ground	34	89.6
5	Mean	23.5±6.224	158.72±69.44

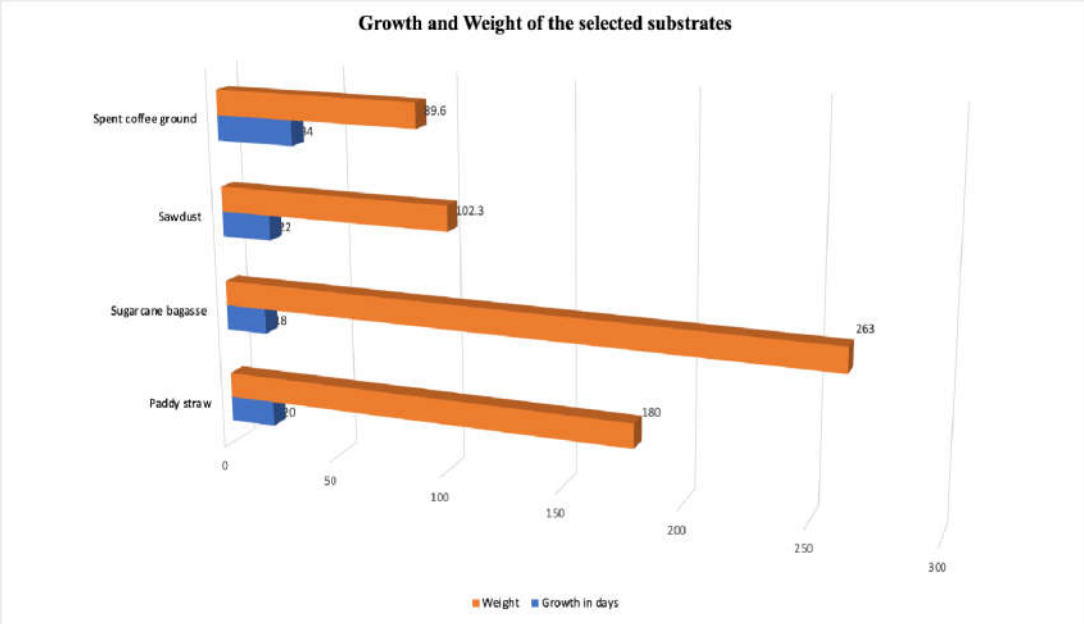

Figure 5: Showing growth and weight of substrates

SUMMARY AND CONCLUSION

Oyster mushroom can be grown in all agricultural wastes and other organic wastes like sawdust, paddy straw, wheat straw, cotton waste, sugarcane molasses etc. Spawn were prepared from two grains, wheat and sorghum. Among the two, wheat performed better compared to sorghum on the growth of mycelium. The substrates used are paddy straw, sugarcane bagasse, and sawdust and coffee grounds.

All these substrates are rich in lignocellulose, which is essential for oyster mushroom growth and development. Also, each substrates possess different components, which are responsible for the growth rate of oyster mushroom (*Pleurotus sajor–caju*). Three types of sterilization methods were used for sterilizing the substrates. There are different factors responsible for the growth, including optimum environmental factors, growth and yield parameters.

Environmental factors including temperature, relative humidity, CO_2 concentration etc. As the study took place in two different places with varying temperature, the temperature with 22°C was suitable and gave a maximum growth and yield compared to the other place. Growth parameters like cap diameter, stipe length varies from one substrate to other based on the components present on it. Among the four different substrate combinations, sugarcane bagasse observed maximum yield and faster growth due to presence of sugar content and the presence of good water holding capacity on it. And spent coffee ground observed the least on growth and yield.

So, to conclude that oyster mushroom can be grown in all agricultural wastes and other organic wastes like sawdust, paddy straw, wheat straw, cotton waste, sugarcane molasses etc. In this present study, oyster mushroom growth is earlier in sugarcane bagasse and also the yield is maximum cost efficient. At the end of this study there was zero waste management is obtained. Therefore, further research in using other type of substrates (plant-based substrates etc.) combination has to be done as an alternative source to the current research and check the growth and yield of oyster mushroom.

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