Evaluation of different substrates for growth and yield parameters of pink oyster mushroom (*Pleurotus djamor*)

ABSTRACT

Cultivation of oyster mushrooms on lignocellulosic agro waste represents one of the most economic organic recycling processes. The present study was carried out to evaluate selected substrate for growth and yield parameters of pink oyster mushroom (*Pleurotus djamor*) on five locally available agro waste substrates *viz.*, paddy straw, sugarcane bagasse, banana leaves, sawdust, cocopeat and cardboard. The experiment was laid out in Completely Randomized Design (CRD) including six treatments with five replications each. The treatment combinations includes paddy straw (100%), paddy straw + sugarcane bagasse + wheat bran (5:4:1), paddy straw + banana leaves + wheat bran (5:4:1), paddy straw + sawdust + wheat bran (5:4:1), paddy straw + cocopeat + wheat bran (5:4:1) and paddy straw + cardboard + wheat bran (5:4:1). Each substrate was supplemented with wheat bran except the control treatment. The study observed that, the treatments combination - paddy straw + sawdust + wheat bran (5:4:1) exhibited the best results in terms of spawn run (8 days), pinhead initiation (9 days). fruiting formation (11 days), number of fruiting bodies (32), length of stipe (2.70cm), yield (200.3g), biological efficiency (164%) and benefit-cost ratio (1:2.8). This empirical information will guide the farmers in the selection of substrates and additives for the successful establishment of mushroom farm with healthy and vigorous mushroom.

Keywords: Biological efficiency (BE), Benefit-cost ratio, Cardboard, Completely Randomized Design (CRD), Mycelial growth, *Pleurotus djamor*, Sawdust, Sugarcane bagasse

1. INTRODUCTION

Mushrooms are fungi with significant nutritional value currently counting around 2000 edible species distributed around the world **(Rathore *et al.*, 2019)**. Oyster mushrooms, known scientifically as *Pleurotus* spp., are well recognized as primary decomposers and their ability to thrive in fruiting bodies on a diverse range of substrates. Mushroom production is one of the most effective biotechnological approaches for recycling lignocellulosic organic waste. It can secrete an array of lignocellulosic enzymes for degrading environmental pollutants **(Kabel *et al.*, 2017; Carrasco *et al.*, 2018)**. Due to the lack of chlorophyll in mushroom it can synthesize its own food so it depends on dead and decay as their saprophytes. And it has the potential to solved many growing global problems like food demand, unemployment, environment pollution etc. Mushroom known for its rich content in vitamin C and B complex and its protein contain with mineral soil which is essential for human body. **(Nongthongbam et al., 2021).**

They can be easily grown on very wide temperature, relatively humidity and CO_2 tolerance (**Thulasi *et al.*, 2010)**. In India, prevalence of varied, agriculture-climatic conditions and availability of vast quantities of lignocellulosic raw materials have stimulated the cultivation of *Pleurotus* spp. Microbial technology help in large-scale recycling of agricultural waste as an alternative way to use agricultural residues / wastes use of organic material in mushroom production. Oyster mushroom ranked third in largest cultivated mushrooms in the world (**Sofi *et al.*, 2014).**

As a reason mushroom cultivation is known to be eco -friendly as it brings no effect to the environment compare to other crop cultivation. Oyster mushroom cultivation depends on many factors such as temperature, humidity and sterility of substrates which act individually or its interaction between them **(Bellettini *et al.*, 2019).** The fruiting body of oyster mushroom differs with respect to stipe length and girth, and pileus width when grown in different substrates. Agricultural wastes such as paddy straw, sugarcane baggase, banana leaves, cardboard, saw dust, cocopeat are good materials for farm substrate production. *Pleurotus* are efficient lignin degraders, which can grow on different agricultural wastes which makes oyster mushroom cultivation an excellent alternative for production of oyster mushrooms when compared to other mushrooms.

Thus, the present study was aimed to determine the feasibility of using different agro based residues treatment for the yield performance of pink oyster mushroom .Therefore the objective of this study is to compare the effectiveness of different substrate treatment methods with supplements on *Pleurotus djamor* growth and yield parameters.

2. MATERIAL AND METHODS

2.1 Site of study

The study was conducted at the Mushroom Crop Room of Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India during October 2023 to January 2024. The maximum temperature reaches up to 47 ºC in summer and drops down to 2.5 ºC in winter.

2.2 Treatments

The substrates selected for the cultivation of pink oyster mushroom were paddy straw, banana leaves, sugarcane bagasse, sawdust, cocopeat and cardboard, each weighing 1kg. The experimental design was laid out in a Completely Randomized Design (CRD). Six treatments were replicated five times thus making total 30 bags. The treatment combination were as follow T_1 – [paddy straw (500g) + sugarcane bagasse (400g) + wheat bran (100g)], T_2 – [paddy straw (500g) + banana (400g) wheat bran (100g)], T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran (100g)], T_4 – [paddy straw (500g) + cocopeat (400g) + wheat bran (100g)], T_5 – [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] as compared to T_0 - (control).Except control, other five treatments were supplemented with wheat bran.

2.3 Substrate preparation

Spawn of *P. djamor* were procured from Directorate of Mushroom Research, Chambaghat, Solan, Himachal Pradesh. Paddy straw including fresh banana leaves and sugarcane bagasse were chopped into 3-5 cm pieces and sun dried. The cardboard was collected from house and shredded into small pieces manually. Sawdust of mango (*Mangifera indica*) was obtained from Industrial area, Prayagraj . After that, substrates were separately combined in the ratio of 5:4:1 Each treatment except paddy straw treatment (control) was supplemented with 10% wheat bran obtained from local rice mill. The mixture of substrates and supplements were

mixed thoroughly . Later on, the substrates such as paddy straw, banana leaves and sugarcane bagasse were soaked in water to get fully wet and then treated with a solution of formaldehyde (2%) and 0.5% Bavistin. **(Varghese and Amritkumar, 2020).** Sawdust, cocopeat, wheat bran were filled in the polypropylene bag of 25cm×15cm in size and autoclaved at 121°C at 15 lbs pressure for an hour and allowed to cool down. Spawning was done at the rate of 40g per 1kg of wet substrates. The bags were subsequently placed long side down, into a mushroom crop room at 20 - 30 °C in dark room and 65-70 % relative humidity until completion of mycelial run. After colonization, the polythene bags were cut and removed and water was sprayed to maintain the moisture. The mature fruiting bodies were harvested by hand picking in clock wise or anti-clock wise rotation before spraying of water. The harvested fruiting bodies were weighed and data was recorded treatment wise and the same procedure was followed for 2nd and 3rd flushes.

Analysis of variance (ANOVA) was used to test among treatments and means were separated using Completely Randomized Design (CRD) at the 5% level of significance

2.4 Biological efficiency (BE)

Biological efficiency (BE) was calculated using the formula which was suggested by (**Chang and Miles 1989).**

$$\text{BE (\%)} = \frac{\text{Total weight of fresh mushroom harvested}}{\text{Dry weight of substrate}} \times 100$$

2.5 Benefit cost ratio

Cost of cultivation, gross return, net return and benefit cost ratio was worked out to evaluate the economics of each treatment, based on the existing market prices of input and output **(Reddy and Reddi, 2004).** The benefit cost ratio was calculated by using the following formula

$$\text{B: C ratio} = \frac{Gross\ return(Rs/kg)}{Cost\ of\ cultivation(Rs/kg)}$$

2.5 Statistical analysis

In the present study, Completely Randomized Design (CRD) was applied for the analysis of the recorded data. The conclusions were drawn on the basis of analysis of variance. The calculated F was compared with the tabulated 5% level of probability at the appropriate degree of freedom **(Fisher and Yates, 1967)**.

3. RESULTS AND DISCUSSION

3.1 Days taken for mycelium running rate

The data presented in the table 1 and depicted in figure 1 revealed that minimum number of days taken for spawn run was observed in treatment T_3 – [paddy straw (500g) + sawdust (400g) + wheat bran (100g)] (8.60 days) followed by T_4 –[paddy straw (500g) + cocopeat (400g) wheat bran (100g)] (9.60 days), T_5 - [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] (10.80), T_1– [paddy straw (500g) + sugarcane bagasse (400g) + wheat bran (100g)] (12 days), T_2 – [paddy straw(500g) + banana leaves (400g) + wheat bran(100g)] (12.80 days) as compared to T_0 - (control) (14.40 days).

3.2 Days taken for pin head Initiation

The data presented in the Table 1 and depicted in figure 1 revealed that number of days taken for pinhead initiation of *P. djamor* was significantly minimum in treatment T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran (100g)] (9 .60 days) followed by T_4 – [paddy straw (500g) + cocopeat (400g) + wheat bran (100g)] (10.60days), T_5– [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] (11.80days), T_1– [paddy straw (500g) + sugarcane bagasse (400g) + wheat bran(100g)] (14days), T_2 – [paddy straw (500g) + dried banana leaves (400g) + wheat bran (100g)] (14.60 days) as compared to T_0 – (control) (15.40days). As per findings from this study, the minimum days taken spawn run and pin head initiation was observed in T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran (100g)]. The probable reasons for this result may be due to presence of the right proportion of alpha-cellulose, hemi- cellulose pectin and lignin in sawdust which may have helped in higher rate of mycelium running and pin head initiation of pink oyster mushroom **(Ashrafuzzaman *et al*., 2009)**. Higher aeration, porosity and uniform particle sizes of sawdust which may have helped in easily and rapidly digestion of lignocellulosic substance as compared to other lignocellulosic waste in pink oyster mushroom **(Osunde, 2019).** The suitable C:N ratio of

sawdust and wheat bran may have helped in higher mycelial growth in pink oyster mushroom **(Ashrafuzzaman *et al*., 2009)**. Wheat bran may have helped in enhancement of the mycelia colonisation of substrates through the aid of extra cellular enzyme **(Adenipekun and Omolaso, 2015)**.

Table 1. Effect of selected substrates on number of days taken for mycelium run, pin head initiation and fruiting body formation

Treatments	Mycelium run (days)	Pin head initiation (days)	Formation of fruiting bodies (days)
T_0- paddy straw (100%)	14.40	15.40	17.40
T_1- paddy straw + sugarcane bagasse + wheat bran (5:4:1)	12.00	14.00	15.20
T_2- paddy straw + banana leaves + wheat bran(5:4:1)	12.80	14.60	15.80
T_3- paddy straw + sawdust + wheat bran(5:4:1)	8.60	9.60	11.60
T_4- paddy straw + cocopeat + wheat bran(5:4:1)	9.60	10.60	12.60
T_5- paddy straw + cardboard+ wheat bran(5:4:1)	10.80	11.80	13.80
CD(5%)	**0.80**	**0.73**	**0.84**

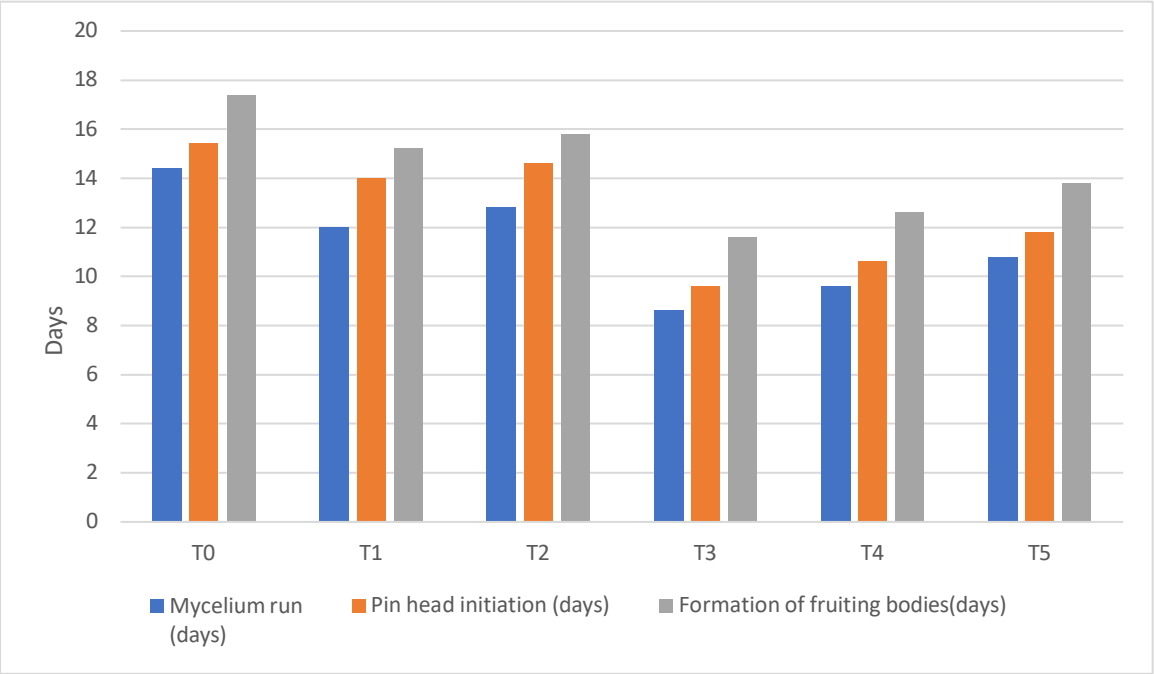

Figure 1. Effect of selected substrates on number of days taken for mycelial run, pin head initiation and fruiting body formation

3.3 Days taken for formation of fruiting bodies

The data presented in the table 2 and depicted in figure 2 that number of days taken for maturation of fruiting body of pink oyster mushroom was significantly minimum in treatment T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran (100g)] (11.60days) followed by T_4 – [paddy straw (500g) + cocopeat (400g) + wheat bran (100g)] (12.60days), T_5 – [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] (13.80days), T_1 - [paddy straw (500g) + sugarcane bagasse (400g) + wheat bran (100g)] (15.20 days), T_1 – [paddy straw(500g) + dried banana leaves (400g) + wheat bran (100g)] (15.80days) as compared to T_0 (untreated check) (17.40days).

The data presented in the Table 2 and depicted in figure 2 revealed that number of fruiting bodies taken for *P. djamor* was significantly maximum in treatment T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran (100g)] (32) followed by T_4 – [paddy straw (500g) + cocopeat (400g) + wheat bran (100g)] (28.3), T_5 – [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] (27), T_1– [paddy straw (500g) + sugarcane bagasse (400g) + wheat bran (100g)] (24.3), T_2 – [paddy straw (500g) + dried banana leaves (400g) + wheat bran (100g)] (22) as compared to T_0 – control(19).

3.4 Stalk length (cm)

The data presented in the Table 2 and depicted in figure 2 revealed that length of stalk (cm) of pink oyster mushroom significantly increased in treatment T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran (100g)] (2.70cm) followed by T_1– [paddy straw (500g) + sugarcane bagasse (400g) + wheat bran (100g)] (2.33cm) T_4– [paddy straw (500g) + cocopeat (400g) + wheat bran (100g)] (2.30cm), T_2 – [paddy straw (500g) + dried banana leaves (400g)+ wheat bran (100g)] (1.93cm), T_5 – [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] (1.66cm) as compared to T_0 - (control) (1.40cm).

3.5 Yield (g)

The data presented in the table 2 and depicted in figure 2 revealed that yield (g) of pink oyster mushroom significantly increased in treatment T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran(100g)] (163.23g) followed by T_4– [paddy straw (500g) + cocopeat (400g) + wheat bran(100g)] (159.40g),T_5 – [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] (152.0g), T_1 – [paddy straw (500g) + sugarcane bagasse (400g) + wheat bran (100g)] (147.57g), T_2 – [paddy straw(500g) + banana leaves (400g) + wheat bran(100g)] (146.27g) as compared to T_0- (control) (120.60g).

Plate 1 Mature fruiting bodies of *Pleurotus djamor*

3.6 Biological efficiency (%)

The data presented in the table 2 and depicted in figure 2 revealed that biological efficiency of pink oyster mushroom substrates significantly increased in treatment T_3 - [paddy straw (500g) + sawdust (400g) + wheat bran (100g)] (227.84%) followed by T_5– [paddy straw (500g) + cardboard (400g) + wheat bran (100g)] (204.62%), T_4 – [paddy straw (500g) +

cocopeat (400g) + wheat bran (100g)] (175.85%), T_1 – [paddy straw(500g) + sugarcane bagasse (400g) + wheat bran (100g)] (159.65%), T_2 – [paddy straw(500g) + banana leaves (400g) + wheat bran (100g)] (110.68%) as compared to T_0- (control) (95%).

The probable reasons of this result may be due to the break-down of lignin present in the sawdust. The degradation of lignin and the production of phenolases which may have helped in oxidized phenolic compounds to simple aromatic compounds that may have helped in absorbed by mushroom mycelium and may have helped in increased growth and yield of pink oyster mushroom. The cellulolytic action of simple and soluble carbohydrates may have helped in production of glucose which was absorbed by the fungal mycelium which may have helped in growth and increased yield of pink oyster mushroom. High cellulose content in sawdust may have helped in enhancement of cellulose enzyme production that may have helped in increased yield of pink oyster mushroom **(Ashrafuzzaman *et al*., 2009)**. Paddy straw may have provided high amount of sugar and amino acids for growth and metabolic purpose which may have helped in increase yield of oyster mushroom **(Ponmurugan *et al*., 2007)**. The wheat bran supply the extra nitrogen and easily degradable carbohydrates to the substrate which may have helped in increased mushroom yield and biological efficiency and **(Oseni *et al.*, 2012)**. Similar findings were also reported by **(Shah *et al*., 2004)** on maximum yield and biological efficiency in sawdust substrates.

3.7 Benefit Cost Ratio

The treatment wise economics of pink oyster mushroom production were estimated and the results have been presented in table 2 the economics analysis of the data over the session that (treated check) T_3 - [paddy straw (500g) + sawdust (400g)+ wheat bran (100g)] was recorded highest gross returns Rs. 150.25, net returns Rs. 96.6 with B:C ratio 1:2.8 followed with T_5 – [paddy straw(500g) + cardboard (400g) + wheat bran (100g)] recorded gross returns of Rs131.5, net returns Rs. 84.25 with B:C ratio 1:2.7 as compared to T_0 - Control gross returns Rs. 108.25, net returns Rs. 56.69 with B:C ratio 1:2.09.

Table 2. Effect of selected different substrates on number of fruiting bodies, stalk length, yield, biological efficiency and benefit cost ratio

Treatments	Number of fruiting bodies	Stalk length (cm)	Yield (g)	Biological efficiency (%)	B:C ratio
T_0- paddy straw (100%)	19	1.40	144.6	82	2.09
T_1- paddy straw + sugarcane bagasse + wheat bran (5:4:1)	24.3	2.33	169.4	119.2	2.2
T_2- paddy straw + banana leaves + wheat bran(5:4:1)	22	1.93	164.3	114.9	2.1
T_3- paddy straw + sawdust + wheat bran(5:4:1)	32	2.70	200.3	164	2.8
T_4- paddy straw + cocopeat + wheat bran(5:4:1)	28.3	2.30	176.4	136.6	2.4
T_5- paddy straw + cardboard+ wheat bran(5:4:1)	27	1.66	175.4	135.5	2.7
CD(5%)	**1.56**	**0.26**	**1.82**	**1.35**	

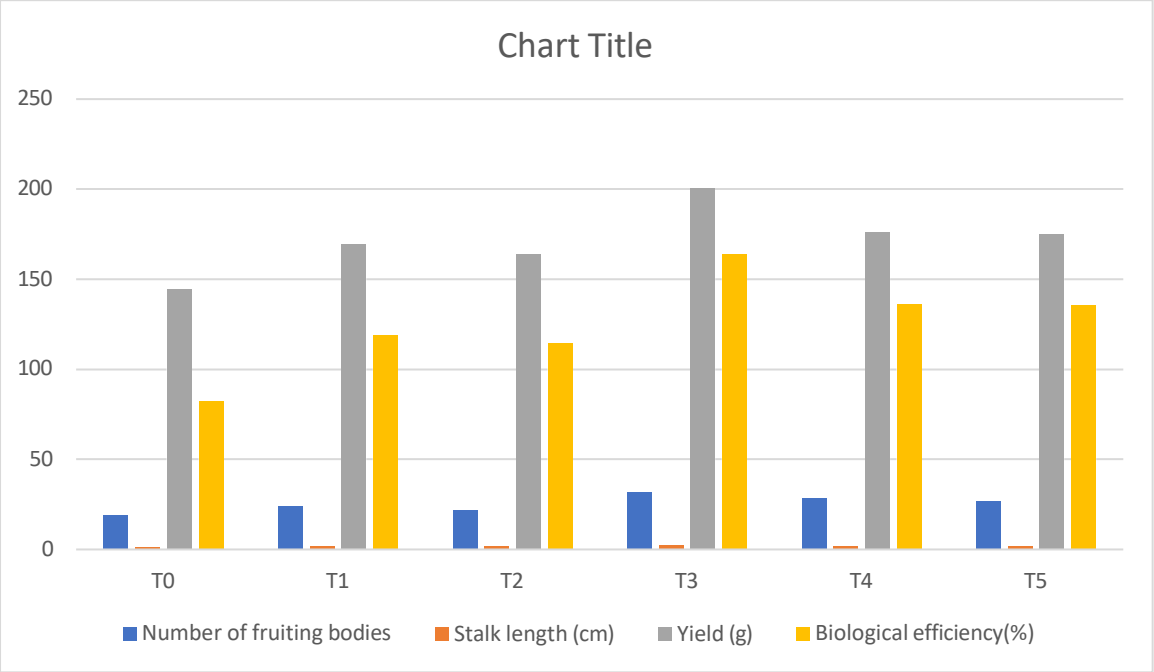

Figure 2. Effect of selected different substrates on number of fruiting bodies, stalk length, yield, biological efficiency and benefit cost ratio

4. CONCLUSION

As per the findings of this study, among the selected treatments, T_3 - paddy straw (500g) + sawdust (400g) + wheat bran (100g) exhibited the best results in terms of spawn run (days), pin head initiation (days). fruiting formation (days), number of fruiting bodies, length of stipe (cm), yield (g), biological efficiency (%) and benefit cost ratio. For the cultivation of oyster mushroom, it is necessary to understand its cultivation practices, its favourable environment such as room temperature, relative humidity, dark period and appropriate aeration. It is worth mentioning that the conclusions drawn from this study are based on observations made during a specific cropping season spanning October 2023 to january 2024, within the agro-climatic conditions of Prayagraj. As such, further research and more experimentation over many seasons should be conducted in future for further recommendations.

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