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Effect of Rice Bran and Soybean Flour on the Growth and Yield of White Oyster Mushroom [*Pleurotus florida* (Mont.) Singer]

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ABSTRACT: Among the various mushrooms widely found in India, *Pleurotus florida* is gaining its popularity due to its vigorous growing and aggressive nature. This creamy white colored mushroom is popularly known as 'White oyster mushroom'. The addition of the supplements with basal substrate has been a common practice for optimization of the C:N ratio, enhance the yield, nutritional and medicinal values. The present investigation was carried out to find the best supplement combination for the cultivation of *Pleurotus florida.* Two supplements namely rice bran and soybean flour in different composition were mixed with the wheat straw to enhance the mushroom yield. Spawning was done @ 3% wet weight of wheat straw. The results of the present investigation revealed that supplemental combination (20% rice bran + 5% soybean flour) used in T_4 recorded significantly less time for spawn run (10.66 days), pinhead initiation (12.66 days), formation of the mature fruiting body (14.83 days). Supplementation with 20% rice bran + 5% soybean flour (T_4) resulted into the significant increase in average width of pileus (7.67 cm), average length of stipe (6.54 cm) and number of fruiting bodies (42.5). Use of 20% rice bran + 5% soybean flour (T_4) in the wheat straw enhanced the yield significantly in all three flushes (394.73 g) and biological efficiency (173.38%) as compared to control.

Keywords: *Pleurotus florida*, rice bran, soybean flour.

INTRODUCTION

Around one-quarter of India's national income originates from the agriculture sector. In this context, mushrooms find a favor which can be grown even by landless people, that too on waste material and could be a source for protein aceous food (Ambili and Nitiya, 2014). Mushroom is fleshy, spore-producing fruiting bodies of some higher fungi. Mushrooms are saprophytes and they include members of the Basidiomycota and some members of the Ascomycota (Jebapriya *et al*., 2013). They consist of two main parts, the mycelium and the fruity body (sporocarp). Mushroom growing is a recycling process done indoors, which does not require arable land or fertile soil, and the potent cash crop can be grown by utilizing farm/forest and industrial wastes. Besides being a fast spinning cash crop, it is also an ideal health food capable to fight malnutrition in general and protein-deficiency in particular (Verma, 2014).

In India, there are five mushroom species viz., white button mushroom (*Agaricus bisporus*), oyster (*Pleurotus* spp.), paddy straw (*Volvariella volvacea*), milky (*Calocybe indica*) and shiitake (*Lentinula edodes*) are in commercial cultivation. Among the white-rot fungi, the genus *Pleurotus* as the oyster mushrooms are famous for conversion of substrate into edible mushrooms (Mandeel *et al*., 2005) and known as 'dhingri' in India well known edible fungi.

White oyster mushroom [*Pleurotus florida* (Mont.) Singer] is an easily cultivated mushroom appropriate for beginners, because of its vigorous mycelium growth. White oyster mushroom is considered to be one of the most efficient producers of food protein, producing 30% of its dry weight. The protein content of mushrooms varies from 4-44% according to the species (Oei, 2003; Okoro and Achuba, 2012).

Mushrooms have antineoplastic, antibacterial, antiviral, hypoglycaemic, hypocholesterolemic, anti-inflammatory and anti-oxidative properties Guillamon *et al.*, (2010); (Wasser, 2011, 2014).

Many of the agro-industrial residues are mainly composed of cellulose, hemicellulose, and lignin, being called lignocellulosic materials. These characteristics make them a suitable substrate for the solid state fermentation process operated by mushrooms, thanks to mushroom's complex enzymes system being able to degrade lignocellulosic materials. Lignocellulosic materials as such having a deficient supply of nutrients primarily require supplementation with various materials, which in general is recommended before

spawning for the enhancement of yield of oyster mushroom. Various oil seed cake, powdered pulses, wheat and rice bran, etc are surprisingly added as supplements (Bahukhandi, 1990). Studies will be therefore made to select an ideal material, which is economical and produces higher yields in a shorter period and with less contamination problem of commercial cultivation of *Pleurotus florida*.

MATERIALS AND METHODS

A. Experimental site

The experiment was carried out in the mushroom crop room and research laboratory, Department of Plant Pathology, SHUATS, Prayagraj, 211007 (U.P), India during the period from January 2021- April 2021.

B. Procurement of spawn

The spawn was procured from the Department of Plant Pathology, SHUATS, Prayagraj. Wheat grain was used for the preparation of spawn. 8 days old wheat grain spawn was used for the production of white oyster mushroom (*Pleurotus florida).*

C. Substrate Preparation

Wheat straw was used as the common substrate for all the treatments. Six months old fresh wheat straw free from any noticeable contaminants was used as the substrate for cultivation. For the preparation of mushrooms bed, the substrates were cut into small pieces (1 to 1.5 inches) and the straw was treated chemically. 100 liters of water was filled in a clean drum of 500 liters capacity. 120 ml of formalin solution, 5-6 g of bavistin/carbendazim 5-6 g carbendazim 50% WP were mixed in the water (Vijay and Sohi, 1987). Wheat straw was gently dipped into the drum containing a chemical solution. The mouth of the plastic drum was tied with the lid or cloth tightly for 16-18hrs. After sterilization of the wheat straw, the bags were taken out and were put on the cement floor for 2hrs. The straw was spread evenly on the plastic sheet and was shade-dried.

D. Bagging and spawning

A unit of 1 kg of wet straw was used for each treatment in perforated polypropylene bags, which were equally distributed in 5 treatments that contain 6 replications each. The moisture content of the straw at the time of spawning was kept around 72-75%. The process of mixing the substrate with the spawn is called spawning. The spawn was mixed with the substrate @ 3% wet weight basis (Tikdari and Bolandnazar, 2012). The spawn was mixed with the substrate in a polypropylene bag weighing up to 1 kg (wet weight) per bag. The spawn was thoroughly mixed with the substrate and should be compactly pressed (Siddhant *et al.*, 2013)

E. Supplementation

In this experiment rice bran and soybean flour were used as organic supplements and thoroughly mixed with the substrates in polypropylene bags as per the required quantity after weighing them properly (Siddhant *et al*., 2015). Later the bags were tied at the open end and are kept in the dark room for 15 days. Holes (8-10) were made with the help of a sterilized needle to facilitate good aeration inside the bag. All the spawned bags were kept at a distance of 20-25 cm apart from each other.

F. Care after Spawning

When the bags were completely colonized by the mushroom mycelium (complete spawn run), the polythene bags were cut and removed. The substrates were sprayed with water 3-4 times per day. After 3-5 days of the removal of polythene bags, small pin heads appeared on all sides of the bags. The little amount of light was provided inside the crop room. The spawned bags were kept in the well-sterilized crop room. The temperature in the crop room was maintained between 20-30°C and relative humidity at 75-85%. To regulate the oxygen and carbon dioxide levels, the crop room was opened for 1-2 hours every day.

G. Harvesting

Fresh and mature fruiting bodies of the *Pleurotus florida* were harvested in 2-3 flushes by hand pick in the clock wise or anti-clockwise rotation before spraying of water without damaging the substrate.

STATISTICAL ANALYSIS

In this experiment Complete Randomized Design (CRD) was adopted. The analysis of variance (ANOVA) technique was applied for drawing conclusion from data. The calculated values were compared the tabulated values at 5% level of probability for the appropriate degree of freedom (Fisher and Yates, 1968).

RESULT AND DISCUSSION

Results indicated the suitability of all the combination of both the supplements tested for the cultivation of *Pleurotus florida* under the agro-ecological condition of Prayagraj, Uttar Pradesh.

A. Effect of treatments on number of days for complete spawn run of Pleurotus florida

The spawn run time was significantly decreased in T_4 (20% rice bran + 5% soybean flour) – 10.66 days followed by T_2 (20% rice bran + 2% soybean flour) – 10.83 days, T_3 (10% rice bran + 5% soybean flour) – 11.83 days, T_1 (10% rice bran + 2% soybean flour) – 12 days, respectively as compared to control T_0 (100% wheat straw) – 14 days. Comparing the result with C.D. value (0.986), among the treatments (T_1 and T_3), (T_2 and T_4) were found to be non-significant to one another and all the treatments were found to be significant over control (T_0).

This is in agreement with the result obtained from another study by Ganjikunta *et al.*, (2020) who reported that as increasing the amount of rice bran in the substrate the time taken for the complete spawn run was reduced. The probable reasons for such findings may be that rice bran is naturally rich source of carbohydrates, amino acids, vitamins, and minerals. The soybean flour is a protein-rich supplement as it provides a large amount of nitrogen to the substrate and enables the mushroom mycelia to fully absorb the available

nitrogen. Such high mycelial growth rate indicated that these level of supplementation consisted of higher carbon to nitrogen ratio (C/N) which favored high mycelial growth rate (Yang *et al.*, 2000).

B. Effect of treatments on number of days for primordial initiation of Pleurotus florida

As per the findings from this study, it was observed that the significantly minimum days were required for pinheads emergence in T_4 (20% rice bran + 5% soybean flour) – 12.66 days followed by T_2 (20% rice bran + 2% soybean flour) – 12.83 days, T_3 (10% rice bran + 5% soybean flour) – 13.83 days, T_1 (10% rice bran + 2% soybean flour) – 14 days, respectively as compared to control T_0 (100% wheat straw) – 16 days.

Comparing the result with CD value (0.986), among the treatments (T_1 and T_3), (T_2 and T_4) were found to be non-significant to one another and all the treatments were found to be significant over control (T_0).

The results of the current study supports the finding obtained by Alam *et al.*, (2010) who reported that the time taken for the primordial initiation was less in 20% rice bran rich substrate (14.3 days) as compared to 10% (16 days). Singh and Prasad (2012) reported that the 5% soybean flour rich substrate taken less time for pinheads emergence (12 days) which also supports our present findings. The probable reasons for such findings may be that the presence of glucose; fructose and trehalose in the substrate containing high amount of both supplements reduce the average time taken for primordial initiation.

C. Effect of treatments on number of days for maturity of fruiting body of Pleurotus florida

As per the findings from this study, it was observed that the days required for fruiting body formation was significantly decreased in T_4 (20% rice bran + 5% soybean flour) – 14.83 days followed by T_2 (20% rice bran + 2% soybean flour) – 15 days, T_3 (10% rice bran + 5% soybean flour) – 16 days, T_1 (10% rice bran + 2% soybean flour) – 16.5 days, respectively as compared to control T_0 (100% wheat straw) – 18.33 days.

Comparing the result with C.D. value (0.884), among the treatments (T_1 and T_3), (T_2 and T_4) were found to be non-significant to one another and all the treatments were found to be significant over control (T_0).

This is in agreement with the results obtained by Jeznabadi *et al.*, (2016) who reported that the maturity of fruiting bodies took 4-7 days after complete spawn run. Singh and Prasad (2012) also found that substrate supplemented with 5% soybean flour took 15 days for the maturity of fruiting bodies and this result supports our present investigation.

D. Effect of treatments on width of pileus (cm) of Pleurotus florida

The average pileus width was significantly greater in T_4 (20% rice bran + 5% soybean flour) – 7.67 cm followed by T_2 (20% rice bran + 2% soybean flour) – 7.43 cm, T_3 (10% rice bran + 5% soybean flour) – 6.43 cm, T_1 (10% rice bran + 2% soybean flour) – 6.16 cm, respectively as compared to control T_0 (100% wheat straw) – 5.93 cm.

Comparing the result with C.D. value (0.374), among the treatments (T_4 and T_2), (T_3 and T_1), (T_1 and T_0) were found to be non-significant to one another and T_4, T_2, T_3 were found to be significant over control (T_0). The results obtained were similar to the results attained by Singh *et al*., (2017) who observed that the width of pileus was significantly maximum in 5% soybean flour (7.16 cm).

E. Effect of treatments on length of stipe (cm) of Pleurotus florida

As per the findings from this study it was observed that the average stipe length was significantly increased in T_4 (20% rice bran + 5% soybean flour) – 6.54 cm followed by T_2 (20% rice bran + 2% soybean flour) – 6.19 cm, T_3 (10% rice bran + 5% soybean flour) – 5.41cm, T_1 (10% rice bran + 2% soybean flour) – 5.16 cm, respectively as compared to control T_0 (100% wheat straw) – 5.06 cm.

Comparing the result with C.D. value (0.646), among the treatments (T_4 and T_2), (T_3, T_1 and T_0), (T_1 and T_0) were found to be non-significant to one another and T_4, T_2 were found to be significant over control (T_0).

The results obtained were similar to the results attained by Tikdari and Bolandnazar (2012) who observed that the length of stipe in 5% soybean meal was 3.86 cm. Chukwurah *et al*., (2013) found that the stipe length and girth are depended on the structure, compactness and physical properties of the substrates.

F. Effect of treatments on number of fruiting bodies of Pleurotus florida

The results from this study revealed that the number of fruiting bodies were significantly higher in T_4 (20% rice bran + 5% soybean flour) – 42.5 followed by T_2 (20% rice bran + 2% soybean flour) – 41.16, T_3 (10% rice bran + 5% soybean flour) – 38.33, T_1 (10% rice bran + 2% soybean flour) –36.66, respectively as compared to control T_0 (100% wheat straw) – 30.33.

Comparing the result with CD value (1.858), among the treatments (T_4 and T_2), (T_3 and T_1) were found to be non-significant to one another and all the treatments were found to be significant over control (T_0).

This is in agreement with the results obtained by Jafarpour and Eghbalsaeed (2012) who reported that the combination of rice bran and soybean flour give maximum fruiting bodies (31.83) as compared to other supplements on the wheat straw substrate.

G. Effect of treatments on yield (g) of Pleurotus florida

The results from this study revealed that significantly highest yield was recorded in T_4 (20% rice bran + 5% soybean flour) –394.73 g followed by T_2 (20% rice bran + 2% soybean flour) – 388.22 g, T_3 (10% rice bran + 5% soybean flour) – 376.37 g, T_1 (10% rice bran + 2% soybean flour) –370.89 g, respectively as compared to control T_0 (100% wheat straw) – 355.30 g.

Comparing the result with CD value (13.986), among the treatments (T_4 and T_2), (T_2 and T_3), (T_3 and T_1) were found to be non-significant to one another and all the treatments were found to be significant over control (T_0).

This is in agreement with the results obtained by Jafarpour and Eghbalsaeed (2012) who reported that the wheat straw mixed with rice bran and soybean flour led to a significantly higher yield (939.33 g) than the substrate without complement. Having high fiber content and a C/N ratio could enhance the digestibility of lingo-cellulose content followed by the high availability of cellulose materials as mushroom nutrients (Fanadzo *et al.*, 2010).

H. Effect of treatments on biological efficiency (%) of Pleurotus florida

As per the observations of this study revealed that the biological efficiency was significantly increased in T_4 (20% rice bran + 5% soybean flour) –173.38% followed by T_2 (20% rice bran + 2% soybean flour) – 169.10%, T_3 (10% rice bran + 5% soybean flour) – 160.98%, T_1 (10% rice bran + 2% soybean flour) – 157.05%, respectively as compared to control T_0 (100% wheat straw) –147.01%.

Comparing the result with C.D. value (9.571), among the treatments (T_4 and T_2), (T_2 and T_3), (T_3 and T_1) were found to be non-significant to one another and all the treatments were found to be significant over control (T_0).

The addition of rice bran supplements to the main substrates significantly improved the biomass and biological efficiency of mushrooms (Buendia *et al.*, 2016). The maximum biological efficiency (%) in T4 20% rice bran + 5% soybean flour may be because rice bran and soybean flour contain high nitrogen content which improved the yield as reported by Fanadzo *et al.*, (2010).

Table 1: Effect of various treatment combinations on the growth parameters of *pleurotus florida.*

Treatments		Spawn run (days)	Primordial initiation (days)	First harvest (days)	Pileus width (cm)	Stipe length (cm)	No. of fruiting bodies
T_0	Wheat straw (100%)	14	16	18.33	5.93	5.06	30.33
T_1	10% rice bran + 2% soybean flour	12	14	16.5	6.16	5.16	36.66
T_2	20% rice bran + 2% soybean flour	10.83	12.83	15	7.43	6.19	41.16
T_3	10% rice bran + 5% soybean flour	11.83	13.83	16	6.43	5.41	38.33
T_4	20% rice bran + 5% soybean flour	10.66	12.66	14.83	7.67	6.54	42.5
C.D. (at 5%)		0.986	0.986	0.884	0.374	0.646	1.858
S.Ed(±)		0.476	0.476	0.427	0.181	0.312	0.897

Table 2: Effect of various treatment combinations on the yield and biological efficiency of *pleurotus florida.*

Treatments		Yield (g)	Biological efficiency (%)
T_0	Wheat straw (100%)	355.30	146.01
T_1	10% rice bran + 2% soybean flour	370.89	157.05
T_2	20% rice bran + 2% soybean flour	388.22	169.10
T_3	10% rice bran + 5% soybean flour	376.37	160.98
T_4	20% rice bran + 5% soybean flour	394.73	173.38
C.D. (at 5%)		13.986	9.571
S.Ed(±)		6.752	4.621

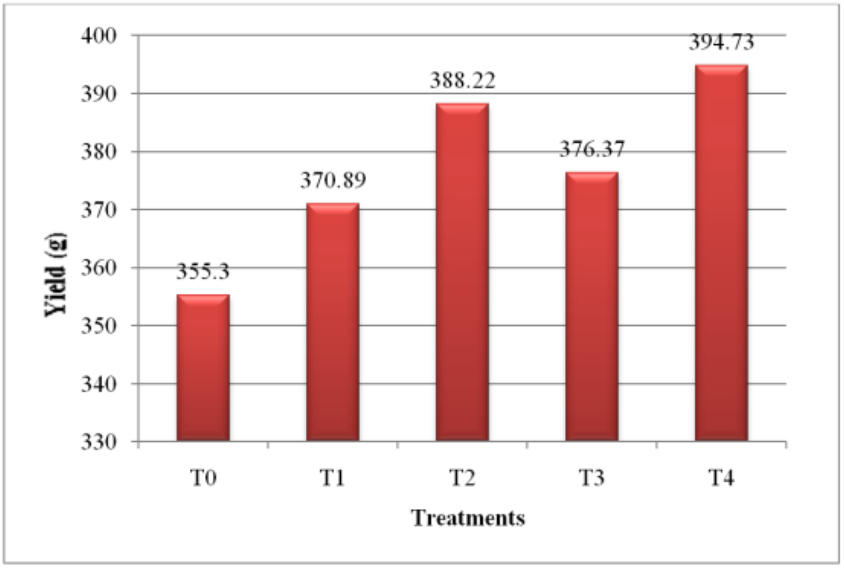

Fig. 1. Effect of various treatments on yield of *Pleurotus florida.*

20% rice bran + 5% soybean flour.

20% rice bran + 2% soybean flour.

10% rice bran + 5% soybean flour.

10% rice bran + 2% soybean flour.

Control (untreated.)

Plate 1. Effect of different treatments on cropping of *Pleurotus florida.*

CONCLUSION

As per the results obtained from this study, the combination of the supplements with wheat straw in T_4 (20% rice bran + 5% soybean flour) took significantly less time for complete spawn run, early primordial initiation and early maturity of the fruiting body. The significantly highest average width of pileus (cm) and stipe length (cm) were also recorded in T_4 (20% rice bran + 5% soybean flour). The significantly maximum number of fruiting bodies was also obtained in this treatment combination (20% rice bran + 5% soybean flour). Among the treatment combinations, T_4 (20% rice bran + 5% soybean flour) recorded significantly higher yield in all three flushes and biological efficiency. Therefore, it is concluded that substrate mixture in T_4 (20% rice bran + 5% soybean flour) is the most suitable combination in terms of increasing growth and yield of white oyster mushroom as compared with control (without supplements). The results of the present study are of one cropping season (January 2021- April 2021) under the Prayagraj conditions, as such to validate the findings more such experiments should be taken up in the future.

FUTURE SCOPE

Rice bran and soybean flour were found effective along with wheat straw can be tested for their efficiency in increasing the growth and yield of white oyster mushroom in terms of productivity.

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Conflict of Interest. As a Corresponding Author, I Sunayana Deb, confirms that no-one else have any conflicts of interest associated with this publication.

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