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Insight into Effect of Crop Straw on Production of Oyster Mushroom (*Pleurotus ostreatus*)

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ABSTRACT: The purpose of this study was to investigate the potential use of rice and wheat crop straws for oyster mushroom cultivation as a means of addressing the issue of disposing of crop straws trash. In this research, we used rice straw with wheat straw in different ration like 100%: 0%, 75%: 25%, 50%: 50%, 25%: 75% and 0: 100% (rice straws: wheat straw) to grow *Pleurotus ostreatus* as an edible mushroom. Wheat straw 100% had the fastest spawn run, pin head initiation, yield and produced the maximum number of fruiting bodies when substrate and complement combinations were evaluated followed by rice straw 75% + wheat straw 25%. By using these crop straws as a substrate for oyster mushroom production, agribusinesses can explore new opportunities by transforming by-products into high-protein mushroom products.

Keywords: *Pleurotus ostreatus*, rice straw, wheat straw, high-protein.

INTRODUCTION

Mushroom growing gives a viable and long-term option for rural and urban people living in poverty to flourish, because of fewer financial and labour requirements (FAO, 2004). White button mushrooms (*Agaricus bisporus*), oyster mushrooms (*Pleurotus* sp.), paddy straw mushrooms (*Volvariella volvacea*) and milky mushrooms (*Calocybe indica*) make up the majority of the total mushroom production in India, each contributing 16%, 7% and 8% of the total production. Mushrooms are higher fungi that feed on organic materials and have fleshy stalks, caps and reproductive structures that produce spores. Due to its nutritious and healing qualities, it has been used as a human food for a long time (Ng'etich *et al*., 2013). According to classification, oyster mushrooms fall within the Phylum Basidiomycota, Class Agaricomycetes, Order Agaricales and Family Pleurotaceae (Singer, 1986). A lignocellulose substance called mushroom substrate promotes the growth, development and fruiting of mushrooms. Oyster mushrooms require carbon, nitrogen and inorganic compounds as their nutritional sources. The substrate which contains less nitrogen and more carbon *viz.,* cellulose, hemicellulose and lignin (*i.e.,* rice and wheat straw, cotton seed hulls, sawdust, waste paper, leaves and sugarcane residue among others) can be used as mushroom substrates (Chitamba *et al.*, 2012). Mushroom yield was discovered to be favourably associated with the physical and chemical composition of substrate formulas such as cellulose/lignin ratio and mineral contents, pH and EC of the substrate, especially C: N ratio (Hoa *et al*., 2015). It has been suggested that organic cellulose-rich materials make suitable substrates for mushroom cultivation. These leftovers are either burned or left out in the open to decay. One way to turn these crop straws products into approved nutritional biomass with high market value would be to grow mushrooms on them. The crop straws from mushroom farming could be used as a livestock feed supplement, thereby supplying more nutrients for livestock feed (Li Xiujin *et al*., 2001). The high nitrogen concentration of substrates was thought to be a barrier to mushroom farming since it increased the media temperature and lengthened the spawn run (Yang *et al*., 2013). On the other hand, it has been demonstrated that having a high protein and nitrogen source can accelerate growth and boost yield (Jafarpour *et al*., 2010).

The aim of this study is to provide a review of current publications on the use of numerous crop strawsas growth substrates for *Pleurotus ostreatus* cultivation, which is known for its specific potential in cellulose, hemicellulose and lignin degradation, with a focus on field-based residues whose ruination could cause pollution. Additionally, one of the major barriers to mushroom farming in Madhya Pradesh (MP) is a lack of awareness of the nutritional value of mushrooms as well as the conservative eating and boring typical diets habits of MP residents. The purpose of this research is to ascertain how various combinations of crop straws, such as wheat, rice, affect the oyster mushroom's production capacity. The implementation of oyster mushroom production method using crop straws is made easier by this study, which also acknowledges the suitability of mushroom farming in the research area to raise neighbourhood standards of living.

MATERIAL AND METHODS

The experiment site is located at 23.09° N latitude and 79.58° E longitude at an altitude of 411.78 m above the sea level. The climate in this area is subtropical, with hot summers and cool winters. The average maximum and minimum temperatures are 20^{o}C to 45^{o}C and 3^{o}C to 27^{o}C and relative humidity ranges from 60 to 70 % respectively. The average annual rainfall is 1350 mm. The research was conducted at the Department of Plant Pathology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidhalya (JNKVV), in November, 2021. Two distinct substrates, including wheat straw, rice straw, had their substrate quality assessed in order to cultivate oyster mushrooms.

The pure culture (Fig. 1) of *Pleurotus ostreatus* was collected from the Mushroom Research Laboratory in Jabalpur and multiplied on potato dextrose agar medium for 7 days before being kept in test tubes with potato dextrose agar. After being sterilised for 30 minutes at 121 °C and 1.5 p.s.i, clean test tubes were allowed to dry in a slant position. To create pure culture, a small amount of soft tissue (from the original *Pleurotus ostreatus* culture) was aseptically transferred to individual PDA slants. At 20.2°C, the culture was infected until the proper growth was attained. Once the mycelium had completely colonised on the agar media, then culture was utilised to prepare spawn.

Fig. 1. Pure culture of *Pleurotus ostreatus.*

Wheat (*Triticum aestivum*) grain was used in the spawn preparation process. For this, wheat grain was partially boiled for 20–25 minutes, rinsed and left to cool at room temperature. The pH of the seed was adjusted to 9.0 and 1% $CaCO_3$ (calcium carbonate) was added as a food supplement (Romero, 2007). The mixture was then divided into two-thirds-full glass bottles, sealed and pasteurised for one hour at 121°C and 1.5 p.s.i to sterilize them. Sterilized vials were aseptically inoculated with some mycelia culture after chilling (14 days old). After that, the bottles were kept at 20.2°C for 14 days to allow the mycelia to completely engulf the seed. After 15 days, the seed spawn was appropriate for utilisation.

Crop straws *viz*., rice and wheat were taken from the local farmsof JNKVV, Jabalpur. The crop straws, such as rice straw was combined with wheat straw at various ratios *viz*., 100%: 0%, 75%: 25%, 50%: 50%, 25%: 75% and 0: 100%. (rice straws: wheat straw). The mix was chemically sanitized by addition of water that contained 750 ppm formaldehyde (Hussain *et al*., 2002) and it was then kept for 18 hours outside at temperatures between 40 °C and 45 °C. Straw was used to remove extra water by putting it out on a flat, sloppy surface covered in polypropylene sheet or by pouring it onto a 150 mesh iron frame (Peng, 1996). *P. ostreatus* was grown using the traditional polythene growth bag technique, with a spawn rate of 3% of the wet weight of the substrate and a wet weight of the substrate maintained at 3 kg (1 kg dry weight). The information was gathered for each treatment up to three full flushes and included the following measurements: time taken for spawn run completion (days), pin head initiation (days), stipe length (cm), stipe width (cm), cap diameter (cm), number of fruiting bodies and yield (g/kg substrate) (50-55 days).

The analysis of the data with four replications was done using a completely randomised design (CRD). The CD (critical differences) was evaluated using statistical techniques for agricultural research at a 5% probability level (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Crop straws substrates are among the most crucial elements in the production of mushrooms. Numerous factors, including the substrate phenomenon, have an effect on the texture and production of mushrooms. In order to evaluate different substrates, wheat straw was combined with varied ratios of rice straw. To determine the greatest producing substrate at the lowest cost, five ratios of each crop straws and wheat straw were used: 100%: 0%, 75%: 25%, 50%: 50%, 25%: 75% and 0: 100% (crop straws: wheat straw). According to the information in Table 1, wheat straw required the least amount of time for *Pleurotus ostreatus* mycelium to colonise (14.40 days) and for pin head initiation (17.20 days) to occur before the substrate was fully colonised. On 100% of the rice straw, the longest times for the completion of the spawn run (17.10 days) and the initiation of the pin head (19.75 days) were noted. The maximum no. of fruiting bodies (23.20) were reported in wheat straw, which showed the similar pattern. Contrarily, rice straw 100% produced the largest stipe length (5.15 cm), stipe width (2.03 cm) and cap diameter (9.88 cm), followed by rice straw 75% + 25% wheat straw (4.80 cm), (1.84 cm) (9.30 cm). In the table below, only averages are shown, which have been lowered by those immature fruit bodies that were raised because of poor management practises and those fruit bodies that emerged at harvest with matured fruit bodies because their neighbouring parts had developed fruit bodies. On these substrates, there was a considerable variation in the yield of mushrooms.

Table 1: Effect of various substrate combinations (rice straw with wheat straw) on growth characteristics of *P. ostreatus.*

Sr. No.	Treatment (*P. ostreatus*)	Spawn run (days)	Pin head initiation (days)	Stipe length (cm)	Stipe width (cm)	Cap diameter (cm)	No. of fruiting bodies
	Experiment - 1						
T_1	Rice straw 100%	17.10	19.75	5.15	2.03	9.88	20.13
T_2	Rice straw 75% + Wheat straw 25 %	16.38	19.20	4.80	1.84	9.30	22.18
T_3	Rice straw 50% + Wheat straw 50 %	16.20	18.80	4.60	1.45	8.50	21.13
T_4	Rice straw 25% + Wheat straw 75 %	15.18	17.90	4.50	1.20	8.33	20.25
T_5	Wheat straw 100%	14.40	17.20	4.20	1.17	7.95	23.20
	$SE_{(m)}\pm$	1.62	1.20	0.08	0.04	0.06	0.23
	$CD_{p\geq 0.05}$	0.54	0.40	0.25	0.12	0.20	0.71

SE±: Standard error of mean, CDp≥0.05: Critical difference, where p = level of significance

According to Fanadzo *et al*. (2010) the high cellulose (35-39 %), hemicellulose (22-30 %) and lignin (12-16 %) content in wheat straw was beneficial for spawn growth and fructification. According to Grimm and Wosten (2018), *P. ostreatus*, as a white-rot-fungi, decomposes cellulose, hemicellulose and lignin, as the main nutrient source for its mycelium growth Cellulose, hemicellulose and lignin are the major constituents of lignocellulosic wastes, which make them ideal for mushroom cultivation. The major source of cellulose is vascular plants' cell wall and it is constructed from D-glucose units through β (1→4)-glucosidic bonds. Cellulose and hemicellulose belong to carbohydrates and their bonds can be broken using acids or enzyme activity (Sundarraj and Ranganathan 2018). *P. ostreatus* is able to degrade these components and produce fruiting bodies rich in essential amino acids, vitamins, minerals and low energy carbohydrates, which positively contributes to mushroom yield (Khan and Umarah 2012).

The study found that it took an average of 14 to 17 days for *P. ostreatus* mycelia to grow on each substrate, which is shorter than previous studies have reported. For example, Jarial *et al.* (2013) observed a spawn run on wheat straw waste taking 18-20 days, while Zhou and Parawira (2022) found that it took between 23 days using similar substrates. Additionally, Fanadzo *et al.* (2010) reported that *P. ostreatus* spawning took 17-20 days on various substrates. The differentiation in days required for spawn run and pinhead initiation on a given substrate may be due to factors such as the mycelial strain, incubation time and type of substrate (Chang and Miles 2004). Additionally, the chemical properties and C:N ratio of the substrates used can also affect the growth period (Zhou and Parawira 2022). Substrates with high protein and nitrogen content have been found to shorten the growth period while increasing average total yield and BE (Jafarpour *et al*., 2010). The C:N ratio of the substrate also plays a role in assessing mushroom productivity with an optimal range of 40-50 (Hoa *et al*., 2015). The maximum fiber content and C:N ratio may improve ligno-cellulose digestibility, resulting in wider availability of cellulose for mushroom nutrition. If nitrogen is linked to the mycelia of the mushroom in this case, it might take more time for the nutrients to reach the mushrooms (Fanadzo *et al*., 2010).

The current investigation found variations in various physical characteristics of the mushrooms, such as stem length, stem width, cap diameter and number of fruiting bodies, when grown on different mixed crop straws substrates. The shortest stem length, width and cap diameter were seen in mushrooms grew on wheat straw 100%. Additionally, the maximum no. of fruiting bodies were observed in mushrooms grown on wheat straw 100%, with the second highest on the mixture of rice straw 25% and wheat straw 75%. The observed range for stem length, width, cap diameter and no. of fruiting bodies for oyster mushrooms were 4.20-5.15 cm, 1.17-2.26 cm, 7.95-10.33 cm and 18.10-23.20, respectively. Similar findings have been reported in other studies that used wheat straw and rice straw as substrates for oyster mushroom cultivation (Nithyatharani and Kavitha 2018; Patel *et al.,* 2019; Zhou and Parawira 2022; Muswati *et al*., 2021).

The study found that the highest average total yield and BE were observed when using 100% WS as a substrate for the development of *P. ostreatus* mushrooms. Additionally, the use of a substrate mix of 75% rice straw and 25% wheat straw also yielded positive results. Higher fibre substrates reduced total growth period and pin head initiation while increasing total average yield and BE in *P. ostreatus*. The study also discovered that laccase and Mn-dependent peroxidase activity were stimulated by the addition of organic nitrogen-rich supplements, which led to an increase in mushroom growth. The results obtained by Onyeka *et al.* (2018); Patel *et al*. (2019); Elattar *et al.* (2019); Muswati *et al.* (2021); Sofi *et al.* (2014) are quite similar to the findings presented here. They concluded that wheat straw is a preferable substrate over other types of crop straws in terms of overall production. It has been observed that wheat with high protein content (9.06%) and nitrogen source (1.45%) can increase production (Fanadzo *et al*., 2010; Jafarpour *et al.,* 2010).

CONCLUSIONS

In this investigation, we investigated the effects of various substrate complements and combinations on *P. ostreatus* development parameters, including growth duration, stipe length, stipe width and cap diameter, as well as fruiting body count, yield. Of the different substrate combinations tested, wheat straw and rice straw were observed to be the most effective. Due to the higher availability of rice straw in this region we can suggest to farmer for optimum yield which is fired through farmers your country and is a major contributor to environmental pollution. These substrates can be sourced from the farmer's own farm and can be easily prepared by cut them into small pieces. This method not only reduces the cost of mushroom cultivation, but also creates a useful protein-rich diet. Furthermore, by using farming crop straws as a substrate for oyster mushroom production, agribusinesses can explore new opportunities by transforming by-products into high-protein mushroom products.

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