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An optimized substrate combination for cultivating exotic King oyster mushroom, *Pleurotus eryngii*

C. CHANDRASHEKARA* and MEERA PANDEY

Division of Crop Protection, ICAR-Indian Institute of Horticultural Research, Bengaluru -560089, Karnataka, India.

E-mail*: chandrashekara.c@icar.gov.in

ABSTRACT: *Pleurotus eryngii*, commonly known as the 'King oyster mushroom', is one of the large and edible fungi native to Europe and Asia. In the present study, different agricultural and lignocellulosic waste materials were evaluated for optimizing cultivation of king oyster mushrooms at ICAR- Indian Institute of Horticultural Research, Bengaluru, India. The highest mushroom yield (146.08 g/kg wet substrate) was achieved with a substrate mixture of sawdust (37.5%), corn cob powder (37.5%), rice bran (12.5%), and wheat bran (12.5%) using a 5% spawn dose. Increasing the spawn dose to 8% further improved the yield, with the same substrate mixture yielding 179.8 g/kg wet substrate. The best yield (211.5 g/kg wet substrate) was obtained with the same substrate mixture at a higher spawn dose, demonstrating a significant improvement in biological efficiency. These findings support the potential for using locally available agricultural waste for sustainable mushroom cultivation, contributing to organic recycling and economic efficiency.

Keywords: Agricultural waste, corn cob powder, King oyster mushroom, *Pleurotus eryngii,* saw dust

INTRODUCTION

Oyster mushrooms (*Pleurotus* spp.) rank second in global mushroom production, following shiitake mushrooms. The king oyster mushroom (*Pleurotus eryngii*), a member of the oyster mushroom family, is edible, basidiomycetic, and saprophytic (Lewinsohn et al., 2002). It is considered the best among *Pleurotus* species due to its excellent cap and stem consistency, culinary qualities, and most extended shelf life among oyster mushrooms (Yildiz et al., 2002). The *P. eryngii* has been commercially cultivated in China, Japan, and Taiwan because of its excellent texture and flavor appeal to consumers (Eguchi et al., 1999; Peng, 1996, 1998; Royse, 1999: Melanouri et al., 2022). *Pleurotus eryngii* is a giant, edible mushroom native to Europe and Asia. While rare in the wild, it is cultivated worldwide and is famous for its buttery flavor and eggplant-like texture, especially in specific Asian cuisines. The species has many common names, including king oyster mushroom, French horn mushroom, king trumpet mushroom, and trumpet royale. Using scientific names helps avoid confusion. The name "king oyster" hints at its close genetic relationship to the popular oyster mushrooms (including *Pleurotus ostreatus*), a group of species native to North America. However, the king oyster does not resemble its relatives much. The *P. eryngii* has a thick, vertical white stem (or "stipe") and a relatively small tan or gray cap, unlike the big white cap and all-but-absent horizontal stipe familiar to American mushroom hunters (Mahbuba et al., 2010; Melanouri et al., 2022).

P. eryngii possesses various medicinal properties, including an anti-inflammatory protein called PEP, which has demonstrated its ability to inhibit the growth of colon cancer cells in both human tissue cultures and live mice without harming healthy cells. Utilizing lignocellulosic waste presents an economical means of organic recycling and supports mushroom cultivation. Different agricultural and lignocellulosic waste materials are employed for this purpose worldwide. In the present study, ICAR-Indian Institute of Horticultural Research has conducted evaluations using locally available agricultural substrates and varying spawning rates to cultivate king oyster mushrooms successfully.

MATERIAL AND METHODS

Various locally available agricultural wastes were evaluated in different combinations and with varying doses of spawn to determine their effect on king oyster mushroom yield. Further, the best substrate combinations were tested with different doses of spawn.

Source of King oyster mushroom and culture preparation

This investigation utilized commercially grown Arka PE-2 obtained from the ICAR-Indian Institute of Horticultural Research, Bengaluru. The pure cultures of various strains were prepared on malt extract agar (MEA) medium. The inoculated Petri dishes were incubated in a growth chamber at 25 ± 2°C in the dark for about ten days until the mycelium had fully developed. This culture was then used to inoculate the mother culture.

The mother culture medium was prepared by boiling sorghum grains, mixing with 4-5 % calcium carbonate, and maintaining a moisture level 48-50%. Glass bottles measuring 550g capacity were filled with 250 g of the mixture, tightly packed, with the necks plugged with non absorbant cotton and covered with butter paper. The bottles were sterilized in an autoclave at 121°C and 15 kg/cm² pressure for one hour. The *P. eryngii* inoculated bottles were placed on a rack in the laboratory for incubation at 25±2°C. The substrate of the mother culture was colonized by mycelial growth within 15–20 days after inoculation. The fully colonized bottles were then used for spawning.

Spawn preparation

White jowar was used to produce the spawn. The jowar was first boiled to a half-cooked stage, and the excess water was drained. The grains were then cooled to 55°C, and CaCO3 was mixed in at a rate of 5% of the wet-boiled grain basis. This substrate mixture was filled into autoclavable polypropylene bags (8x16 inches) plugged with nonabsorbent cotton plugs with autoclavable neck rings. The bags were sterilized at 121°C for 3 hours under 1 kg/cm² pressure. After cooling to room temperature, the sterilized bags were inoculated with the Generation-2 spawn of the selected strains to be tested separately. These inoculated bags were incubated for 45 days in a dark room at 25 ± 2°C for mycelium growth.

Cropping and harvesting

After the mycelial growth was complete (45 days after spawn inoculation), slits were made in the fully colonized substrate bags, which were then moved to the cropping room. The temperature, relative humidity, and light were maintained at 18°C, 85%, and approximately 500 lux, respectively. Mushrooms were harvested when the cap surfaces were flat to slightly up-rolled at the margins. Two to three flushes of mushrooms were harvested from each bag. The yield and various quality parameters of the mushrooms were recorded regularly.

Statistical analysis

The experiment was conducted using a completely randomized design with ten replications (n = 10). Data were analyzed and graphs were created using the statistical program SPSS 12.0 and Microsoft Excel.

RESULTS AND DISCUSSION

The growth and yield patterns of the *P. eryngii* strain cultivated on various combinations of locally available substrates are presented in Table 1. The highest mushroom yield (146.08 g/kg wet substrate) was achieved with a substrate mixture of sawdust (37.5%), corn cob powder (37.5%), rice bran (12.5%), and wheat bran (12.5%), which was significantly different from all other treatments and the control. The second highest yield (127.2 g/kg wet substrate) was obtained with a substrate mixture of coir pith (40%), sawdust (40%), rice bran (10%), and wheat bran (10%). This was followed by a yield of 110.58 g/kg wet substrate using a mixture of sawdust (40%), wood chips (40%), rice bran (10%), wheat bran (10%), and CaCO3 (3%).

Table1. Evaluation of different locally substrate for king oyster mushroom with 5% spawn dose

Treatment	Yield (g/kg wet substrate)	Biological efficiency (%)	Average fruit body weight (g)
T1- Coir pith (40%), Saw dust (40%), Rice bran (10%), Wheat bran (10%)	127.2	36.29	35.65
T2- Sawdust (40%), Wood chips (40%), Rice bran (10%), Wheat bran (10%), CaCO3 (3%)	110.58	31.57	25.65
T3- Sawdust (40%), paddy straw powder (40%), RB(10%), WB(10%)	33.5	9.57	19.8
T4- Sawdust (26.7%), Paddy straw powder (26.7%), Corn cob powder (26.7%), Rice bran (10%), Wheat bran (10%)	101.62	28.74	26.52
T5- Sugar Cane pith (80%), Rice bran (20%), CaCO3 (3%)	44.98	12.86	25.65
T6-PSP (40%), Sugarcane pith 40%), Rice bran (10%), WB(10%)	55.58	16.00	24.52

T7-paddy straw powder (80%), Rice bran (10%), Wheat bran (10%)	15.02	4.29	19.58
T8- Sawdust (37.5%), Corn cob powder (37.5%), Rice bran (12.5%), Wheat bran (12.5%)	146.08	41.71	49.50
CV	5.27		
CD (0.01)	3.83		

The highest mushroom yield (179.8 g/kg wet substrate) was achieved with a substrate mixture of sawdust (37.5%), corn cob powder (37.5%), rice bran (12.5%), and wheat bran (12.5%), which differed significantly from all other treatments and the control (Table 2). The second highest yield (149.2 g/kg wet substrate) was obtained with a substrate mixture of coir pith (40%), sawdust (40%), rice bran (10%), and wheat bran (10%). Following this, a yield of 138.5 g/kg wet substrate was recorded with a mixture of sawdust (40%), wood chips (40%), rice bran (10%), wheat bran (10%), and CaCO3 (3%). Mahbuba et al. (2010) reported similar findings, showing greater biological efficiency with sawdust substrates compared to rice straw-based substrates. Amin et al. (2007) observed the highest number of fruiting bodies of various oyster mushroom species on sawdust compared to rice straw. While king oyster mushrooms produce fewer fruiting bodies, their texture and shelf life are superior to other *Pleurotus* species. Comparable results were also noted with shiitake mushrooms (Sarker et al., 2009).

Table2. Evaluation of different locally substrate for king oyster mushroom with 8% spawn dose

Treatment	Yield (g/kg wet substrate)	Biological efficiency (%)	Average fruit body weight (g)
T1- Coir pith (40%), Saw dust (40%), Rice bran (10%), Wheat bran (10%)	149.2	42.6	40.58
T2- Sawdust (40%), Wood chips (40%), Rice bran (10%), Wheat bran (10%), CaCO3 (3%)	138.5	39.6	31.65
T3- Sawdust (40%), paddy straw powder (40%), RB (10%), WB (10%)	112.5	32.1	25.6
T4- Sawdust (26.7%), Paddy straw powder (26.7%), Corn cob powder (26.7%), Rice bran (10%), Wheat bran (10%)	125.6	35.9	32.52
T5- Sugar Cane pith (80%), Rice bran (20%), CaCO3 (3%)	112.6	32.2	31.56
T6-PSP (40%), Sugarcane pith 40%), Rice bran (10%), WB (10%)	99.8	28.5	29.5
T7-paddy straw powder (80%), Rice bran (10%), Wheat bran (10%)	124.5	35.6	26.5
T8- Sawdust (37.5%), Corn cob powder (37.5%), Rice bran (12.5%), Wheat bran (12.5%)	179.8	51.4	53.6
CV	1.82		
CD (0.01)	4.59		

The growth and yield patterns of the *P. eryngii* strain cultivated on various combinations of locally available substrates using an 8% spawn dose were recorded (Table 3). The highest mushroom yield (211.5 g/kg wet substrate) was achieved with a substrate mixture of sawdust (37.5%), corn cob powder (37.5%), rice bran (12.5%), and wheat bran (12.5%), which differed significantly from all other treatments and the control. The second highest yield (152.5 g/kg wet substrate) was obtained with a substrate mixture of coir pith (40%), sawdust (40%), rice bran (10%), and wheat bran (10%). Following this, a yield of 145.5 g/kg wet substrate was recorded with a mixture of sawdust (40%), wood chips (40%), rice bran (10%), wheat bran (10%), and CaCO3 (3%). Rashid et al. (2016) assessed five types of sawdust for cultivating the white oyster mushroom *Pleurotus florida*. They found that the raintree sawdust substrate yielded the highest biological efficiency (212.8%) compared to the other sawdust types. Sarita et al. (2021) studied the optimal spawn rate for maximum yield and biological efficiency in oyster mushrooms. They cultivated two oyster mushroom strains (PL-19-05 and PL-19-06) using wheat straw as the substrate and wheat grain spawns at different rates (3%, 4%, 5%, and 6%). Among these rates, the highest yield and biological efficiency were observed at the 6% spawn rate, indicating its suitability for achieving higher yields under humid conditions in the Udaipur region. Alananbeh et al. (2014) highlighted that increasing the spawning rate significantly enhances yield, biological efficiency, and the total number of fruiting bodies. Similarly, Deora et al. (2021) observed a proportional increase in yield with the spawn rate up to a certain threshold, beyond which higher spawn rates also led to increased bag temperatures.

CONCLUSION

King oyster is considered the best among *Pleurotus* species due to its excellent cap, stem consistency, culinary qualities, and most extended shelf life among oyster mushrooms. This mushroom is being cultivated on many substrate combinations throughout the world. In the present studies, a substrate combination of sawdust, corn cob powder, rice bran, and wheat bran with a 10% spawn dose has potential commercial applications for achieving improved quality and higher yields of King oyster mushrooms in India.

Table 3. Evaluation of different locally substrate for king oyster mushroom with 10% spawn dose

Treatment	Yield (g/kg wet substrate)	Biological efficiency (%)	Average fruit body weight (g)
T1- Coir pith (40%), Saw dust (40%), Rice bran (10%), Wheat bran (10%)	152.5	43.6	41.52
T2- Sawdust (40%), Wood chips (40%), Rice bran (10%), Wheat bran (10%), CaCO3 (3%)	145.5	41.6	33.65
T3- Sawdust (40%), paddy straw powder (40%), RB(10%), WB(10%)	125.5	35.9	27.5
T4- Sawdust (26.7%), Paddy straw powder (26.7%), Corn cob powder (26.7%), Rice bran (10%), Wheat bran (10%)	135.5	38.7	34.65
T5- Sugar Cane pith (80%), Rice bran (20%), CaCO3 (3%)	128.5	36.7	35.65
T6-PSP (40%), Sugarcane pith 40%), Rice bran (10%), WB (10%)	129.5	37.0	34.65
T7-paddy straw powder (80%), Rice bran (10%), Wheat bran (10%)	135.6	38.7	31.52
T8- Sawdust (37.5%), Corn cob powder (37.5%), Rice bran (12.5%), Wheat bran (12.5%)	211.5	60.4	56.5
CV	1.94		
CD (0.01)	4.87		

REFERENCES

Alananbeh, K.M., Bouqellah, N.A. and N. S. Al Kaff. 2014. Cultivation of oyster mushroom *Pleurotus ostreatus* on date-palm leaves mixed with other agro-wastes in Saudi Arabia. *Saudi Journal of Biological Sciences*, **21**:616-625.

Amin, S.M., Rahman, M.M., Hossain, M.M., Haque, M.M. and Sarker, N.C. 2007. Effect of different substrates on the growth and yield of five selected oyster mushrooms. *Bangladesh Journal of Mushroom,* **1**: 21-25.

Deora, A. 2021. Cultivation of Kabul Dhingri (*Pleurotus eryngii*) mushroom by standardizing protocols in subtropical zones of world. *Scientific Reports*, **11**(1):14692.

Eguchi, F., Watanabe, Y., Sudo, K. and Higaki, M. 1999. Pharmacological effects of *Pleurotus eryngii* on the hyperlipemia. In: Proceedings of 3rd International Conference on Mushroom Biology and Mushroom Products. University of Western Sydney, Hawkesbury, 333-339.

Eirini-Maria Melanouri, Marianna Dedousi and Panagiota Diamantopoulou. 2022. *Carbon Resources Conversion,* **5**: 52-60.

Gyorfi, J. and Hajdu, C. S. 2007. Casing-material experiments with *P. eryngii.* International *Journal of Horticultural Science*, **13**: 33-36.

Lewinsohn, D., Wasser, S. P., Reshetnikov, S. V., Hadar, Y. and Nevo, E. 2002. The Pleurotus eryngii species complex in Israel: distribution and morphological description of a new takson. *Mycotaxon*, **81**: 51-67.

Mahbuba Moonmoon, Md. Nazim Uddin., Saleh Ahmed., Nasrat Jahan Shelly and Md. Asaduzzaman Khan. 2010. Cultivation of different strains of king oyster mushroom (*Pleurotus eryngii*) on saw dust and rice straw in Bangladesh. *Saudi Journal of Biological Sciences,* **17**: 341-345.

Peng, J.T. 1996. Research on the Automatic Production of Pleurotus eryngii (DC.:Fr.) Quel (in Chinese). In: A Report on Agricultural Research in the Republic of China on Taiwan (Crops) 1992–1996, Council of Agriculture, Executive Yuan, ROC. 89- 91.

Peng, J. T. 1998. Research on the Automatic Production of King Oyster Mushroom (in Chinese). In: Proceedings of 1998 Agricultural Science and Technology Exhibition. Council of Agriculture, Executive Yuan, ROC, 44-46.

Md.Harun-or-Rashid, Debu Kumar Bhattacharjya, Ratan Kumar Paul, Md. Samsur Rahaman, Md. Saifur Rahaman, Md. Nuruddin Miah and Kamal Uddin Ahmed. 2016. Effect of different saw dust substrates on the growth and yield of Oyster Mushroom (*Pleurotus florida*). *Bioresearch Communications*, **02 (**01): 193-199.

Royse, D. J. 1999. Yield stimulation of king oyster mushroom, *Pleurotus eryngii*, by brewer's grain and spawn mate IISE supplementation of cottonseed hull and wood chip substrates. Mushroom News, 47: 4-8.

Sarita, S.S., Sharma, Somdutt, Chirag Gautam and Roop Singh. 2021. *The Pharma Innovation Journal.* **10**(9): 1783-1787.

Sarker, N.C., Ahmed, S., Hossain, K., A. Jahan and N.M.M. Quddus, 2009. Performance of different strains of shitake mushroom (Lentinus edodes) on saw dust. *Bangladesh Journal*, Mushroom, **3**: 1-7.

Yildiz, S., Yildiz, U.C., Geze, E. D. and Temiz, A. 2002. Some lignocellulosic wastes used as raw material in cultivation of the Pleurotus ostreatus culture mushroom. *Process Biochem*, **38:** 301-306.

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