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Evaluation of *Pleurotus eryngii* (King Oyster Mushroom) Cultivation on Different Substrates under Kashmir Conditions

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Abstract

The study is of great relevance with present day where mushrooms have immunity enhancing properties and they convert agro-wastes into protein rich food. India is having a youth population of about 750 million and mushroom cultivation has good potential for employment and contributes in national income. The key aspects undertaken during research were the cultivation on low-cost substrates viz, wheat straw, willow saw dust and popular saw dust and production and yield attributes of *Pleurotus eryngii* under controlled mushroom growing room at Integrated Mushroom Development Centre (IMDC). There was much difference in yields with respect to substrates (wheat straw, Willow and popular saw dust utilized during the trial. Mycelium colonized within fifteen days on wheat straw followed by willow and popular saw dust. The pinhead and fruit formation was observed in wheat straw within 10 days after mycelium run and 15 days in willow and 20 days in popular saw dust. The biological efficacy was observed 72% in wheat straw 68 percent in willow and 55 percent in popular saw dust.

***Key words*:** *Pleurotus eryngii*, King oyster mushroom, Wheat straw, Saw dust, Substrate, Biological efficiency, Mushroom cultivation

Mushroom production in India began as an experimental initiative at Solan in the early 1960s, supported by the establishment of research facilities and necessary infrastructure and the involvement of progressive farmers. The success of pioneering commercial farms subsequently encouraged other enterprising farmers to adopt button mushroom cultivation under natural climatic conditions. By the mid-1970s, mushroom cultivation had emerged as an important commercial enterprise in India, catering to both domestic and export markets. Against this backdrop, white button mushroom (*Agaricus bisporus*) cultivation was introduced in Kashmir during 1964–65 by the Department of Agriculture on an experimental basis. Owing to its profitability and adaptability, mushroom cultivation gradually gained popularity among farmers and became an important component of agricultural diversification in the region [1-2]. Growing the mushrooms from the obtained best results will result in better production with higher income even for the marginal farmers in subtropical zones. The most cultivated mushrooms worldwide are Button mushroom (*Agaricus bisporus*) followed by *Pleurotus sp.* that constitutes up to 27% of the cultivated mushrooms [3]. *Agaricus bisporus* has prominently been cultivated in subtropical areas. *Pleurotus eryngii* is still new to this area and regulating its cultivation protocols is compulsory so that farmers can get good returns and nutritive food at minimum costs. Mushrooms are large, fleshy and higher fungi that possess stalks and caps [4]. They are rich in nutrition and health beneficent substances and are good source of protein and fiber [5]. The protein in mushrooms has a digestibility quotient of up to 95%, while their carbohydrates are readily digestible and comprise starch, pentoses, hexoses, disaccharides, amino sugars, sugar acids, and sugar alcohols [6]. Edible mushrooms are low in lipids and calories but contain a high proportion of polyunsaturated fatty acids and dietary fibre, which promotes prolonged satiety and makes them a valuable component of a healthy, calorie-conscious diet [7].

King Oyster (*Pleurotus eryngii*) is considered as the best of all *Pleurotus* species due to its splendid consistency of thick stem and cap and longer shelf life than any other Oyster mushrooms. Lower water content and firm flesh of the fruiting body may be the reasons that are making it best in quality [8-9]. It can be cultivated successfully on a wide range of lignocellulosic substrates, making it highly adaptable to diverse agricultural and agro-industrial residues. The cultivation of *Pleurotus eryngii* has been successfully carried out on a wide range of agricultural and agro-industrial residues across

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different regions of the world, including sawdust, wheat and millet straw, soybean straw, cotton waste, peanut shells, sugarcane bagasse, and wheat and rice bran [10], [11-16]. Mushroom cultivation is an efficient biotechnological process for the sustainable recycling and valorization of lignocellulosic organic wastes into nutritious and economically valuable biomass [17]. Mushrooms are great source of proteins (20-25%), polysaccharides (37-48%), fibers (13-24%), vitamins and minerals [18-19] and has some secondary metabolites, including phenolics, polyketides, terpenes and steroids [20]. It is a cholesterol-lowering dietary agent as it produces ergosterol and lanosterol and contains chemicals that boost the immune system and has anti-hypertensive, immune-modulating, antitumor, antibacterial, antioxidant, anti-hypocholesterolemic, anti-hyperglycemic, antiviral, antifungal, anti-inflammatory and anti-osteoporotic effects [21].

MATERIALS AND METHODS

Tissue culture / Spawn production

Pleurotus eryngii Culture/fruit was collected from Mushroom Training Center Wadoora SKUAST-Kashmir, Shelly Farm Zakora and Mushroom Farm Bagahat Barzullah Srinagar. The meristematic part of kingoyster was taken and put in PDA, MEA and wheat grains for growth. Within 15 days all media was fully colonized and was used for spawn production.

Table 1 Quantity of substrates and supplements used for mushroom cultivation

S. No.	Substrates	Quantity (wet weight)	Supplements		
			Wheat brawn @ 25%	Calcium carbonate ($CaCO_3$) @ 2%	Calcium sulphate ($CaSO_4$) @ 2.5%
1.	Wheat straw	35 kg	@ 875 gm	70 gm	87.5 gm
2.	Willow saw dust	10 kg	@ 250 gm	20 gm	25 gm
3.	Popular saw dust	10 kg	@ 250 gm	20 gm	25 gm

The moisture content of each substrate was maintained at 55-60%, after which the substrates were filled into polypropylene bags and glass bottles at a rate of 250 g per container, respectively.

Sterilization methods

The substrates were filled in PP bags and glass botlles @ 250 gm per PP bags/bottles and autoclaved at 15 lbs and 121 °C for 1.5 to 2 hours.

Spawning

All the PP bags (17 × 7cm) as well as bottles (750ml) were inoculated with @ 5% spawn at Mushroom Research Lab, Integrated Mushroom Development Centre, Lal Mandi Srinagar on dated 15-05-2026 on wheat straw, willow saw and popular saw dust. The PP bags as well as bottles were kept in controlled mushroom growing room for vegetative and reproductive growth.

RESULTS AND DISCUSSION

Effect of different substrates

The different substrates viz wheat straw, willow saw dust and popular saw dust were used in the trial. As per the observation recorded, the PP bags containing wheat straw take minimum time for mycelium colonization of *Pleurotus eryngii* (12 DAS) followed by willow saw dust (17 DAS). Maximum time (20 DAS) for spawn run was recorded on popular saw dust [22]. In case of glass bottles wheat straw, willow saw dust and popular saw dust were used. As per the data recorded, the glass bottles containing willow saw dust take minimum time for mycelium colonization of *Pleurotus eryngii* (28 DAS) followed by popular saw dust (30 DAS). Maximum time (35 DAS) for spawn run was recorded on wheat straw. In case of glass bottles the willow saw dust bottles took minimum time for full colonization of Kingoyster (28 days) followed by popular saw dust (32 days) and wheat straw (35 days) [23].

Pinhead initiation

The same trend was being followed with the time taken for initiation of pinheads in PP bags. Minimum days for initiation of pinning were recorded on wheat straw (8 days) followed by willow saw dust (13 days) and 18 days for popular saw dust after the full mycelium run. The pin head formation in case of bottles, the willow saw dust taken (12 days) followed by popular saw (18 days) dust and wheat straw (18 DAS). In case of glass bottles for initiation of pinheads after the full mycelium run, minimum days for initiation of pinning were recorded on willow saw dust (10 days) followed by popular saw dust (11 days) and 15 days for wheat straw [24].

Table 2 Effect of different substrates and containers on mycelial run and pinhead initiation in mushroom cultivation

Substrate	PP bags (Substrate 250gm wet wt.)		Glass bottles (Substrate 250gm wet wt.)	
	Days taken in mycelium run	Days taken in pin head initiation	Days taken in mycelium run	Days taken in pin head initiation
Wheat straw	12	8	32	15
Willow saw dust	17	13	28	10
Popular saw dust	20	18	30	11

All the observations are average of five replications

Fruit formation

The maximum number of fruiting bodies and the highest biological efficiency (88.4%) was obtained in case of wheat straw followed by willow saw dust and popular saw dust. In wheat straw fruit body weight of *Pleurotus eryngii* reaches up to 80–90 g with 10–12 cm broad pileus, 8–9 cm long and 6–7 cm thick stipe. The average yield per PP bag was obtained 170 to 210 gms in case of wheat straw followed by willow saw dust 150 to 190 gms and 100 to 125 gm in popular saw dust [25]. There was significant difference in case of time taken for mycelium run and yields of Kingoyster mushroom on these substrates as well as PP bags and glass bottles.

Table 3 Effect of different substrates on fruiting, yield, biological efficiency and fruit body characteristics of mushroom in PP bags

Substrate	PP bags (Substrate 250gm wet wt.)						
	No. of fruiting bodies / bag	Yield (g) / bag	Biological efficiency %	Average fruit body weight (g)	Fruit body measurement		
					Pileus (cm)	Stipe length (cm)	Stipe diameter (cm)
Wheat straw	03	200	80.0	66.6	6.8	4.9	2.6
Willow saw dust	03	170	68.0	56.0	6.5	4.5	2.3
Popular saw dust	02	120	48.0	40.0	5.9	4.0	1.5

All the observations are average of five replications

Table 4 Effect of different substrates on spawn run, pinhead initiation, fruiting, yield, biological efficiency and fruit body characteristics of mushroom

Substrate	Days in spawn run	Days taken in pin head initiation	No. of fruiting bodies	Yield (g)	Biological efficiency %	Average fruit body weight (g)	Fruit body measurement		
							Pileus (cm)	Stipe length (cm)	Stipe diameter (cm)
Wheat straw	19	25	30	767	76.7	25.3	6.5	4.6	2.0
Willow saw dust	18.4	24.2	32.8	884.0	88.4	31.4	6.8	4.8	2.4
Popular saw dust	8.0	12.4	30.2	750.0	75.0	26.7	6.2	4.3	1.5

All the observations are average of five replications

Fig 1 *Pleurotus eryngii* (King Oyster Mushroom) cultivated on lignocellulosic substrate under controlled growing conditions

The data in (Table 4) clearly indicate that the type of substrate had a substantial effect on spawn colonization, pinhead initiation, fruiting, yield, biological efficiency, and fruit body characteristics. Among the three substrates evaluated, willow sawdust performed best overall, whereas poplar sawdust showed the fastest colonization and pinhead initiation.

The days required for spawn run varied considerably among substrates. Poplar sawdust recorded the shortest spawn-run period (8.0 days), followed by willow sawdust (18.4 days) and wheat straw (19 days). The rapid colonization of poplar sawdust may be attributed to its relatively favourable physical structure, moisture-holding capacity, aeration and availability of readily utilizable nutrients, which may have facilitated rapid mycelial growth. In contrast, the comparatively slower colonization of wheat straw may be associated with its more complex lignocellulosic structure and differences in moisture retention and nutrient availability [26].

A similar trend was observed for pinhead initiation, with poplar sawdust requiring only 12.4 days, compared with 24.2 days in willow sawdust and 25 days in wheat straw. Early pinhead formation on poplar sawdust suggests that this substrate provided favourable conditions for rapid transition from vegetative mycelial growth to reproductive development. However, faster pinhead initiation did not necessarily translate into higher yield, indicating that substrate suitability depends not only on the speed of colonization but also on its capacity to support sustained fruit body development [27].

The number of fruiting bodies was highest on willow sawdust (32.8 fruiting bodies), followed by poplar sawdust (30.2) and wheat straw (30.0). The greater number of fruiting bodies on willow sawdust may be due to better moisture retention, favourable aeration and a more suitable carbon-to-nitrogen balance, which provided favourable conditions for the development and maintenance of more fruiting primordia [28].

The substrate effect was particularly evident in yield and biological efficiency. Willow sawdust produced the highest yield (884.0 g) and biological efficiency (88.4%), followed by wheat straw (767 g; 76.7%) and poplar sawdust (750 g; 75.0%). The superior performance of willow sawdust could be attributed to its favourable lignocellulosic composition, moisture retention and physical characteristics, which probably supported efficient enzymatic degradation of the substrate and greater conversion of substrate nutrients into mushroom biomass. Biological efficiency followed the same pattern as yield because it represents the efficiency with which the mushroom converts the substrate into fresh fruit bodies [29].

The average fruit body weight was also highest in willow sawdust (31.4 g), followed by poplar sawdust (26.7 g) and wheat straw (25.3 g). This indicates that willow sawdust not only supported a greater number of fruiting bodies but also promoted better individual fruit body development. The combination of higher fruiting-body number and greater individual fruit body weight explains its superior overall yield [30].

With respect to fruit body characteristics, willow sawdust produced the largest pileus (6.8 cm), longest stipe (4.8 cm) and greatest stipe diameter (2.4 cm). Poplar sawdust recorded the smallest values for all three traits, with a pileus diameter of 6.2 cm, stipe length of 4.3 cm and stipe diameter of 1.5 cm. The better fruit body development on willow sawdust may be related to its ability to maintain an appropriate moisture regime and provide sufficient nutrients during fruiting. Adequate moisture and nutrient availability are particularly important during fruit body expansion and biomass accumulation [31].

An important observation is that poplar sawdust supported the fastest spawn run and pinhead initiation but did not produce the highest yield, whereas willow sawdust took longer to colonize but ultimately produced superior yield, biological efficiency and fruit body quality. This suggests that rapid mycelial colonization alone is not a reliable indicator of final productivity. The nutritional composition, lignocellulosic structure, moisture-holding capacity and physical properties of the substrate collectively determine fruiting performance [32].

Conclusively, willow sawdust was the most suitable substrate among those tested, as it recorded the highest number of fruiting bodies, yield, biological efficiency, average fruit body weight and fruit body dimensions [33-34]. Thus, willow sawdust appears to provide a more favourable substrate environment for achieving higher productivity and better-quality fruit bodies, despite its relatively slower spawn colonization and pinhead initiation.

CONCLUSION

The present study demonstrated that *Pleurotus eryngii* can be successfully cultivated on locally available low-cost lignocellulosic substrates, with wheat straw proving to be the most suitable substrate among those evaluated. Wheat straw recorded the fastest mycelial colonization in PP bags (12 days), earlier pinhead initiation (8 days), the highest yield (200 g/bag), and the highest biological efficiency (80%), followed by willow saw dust and popular saw dust. Willow saw dust showed comparatively better performance in glass bottles, particularly with respect to mycelial colonization and pinhead initiation. Overall, wheat straw was found to provide better productivity and economic potential for *Pleurotus eryngii* cultivation under the controlled conditions of Integrated Mushroom Development Centre (IMDC), Srinagar. The findings indicate that utilization of locally available agro-residues and saw dust can support low-cost king oyster mushroom production while contributing to the recycling of lignocellulosic wastes, nutritional security, and income generation for small and marginal farmers. Further studies on substrate supplementation, environmental conditions, and optimization of cultivation practices are recommended to enhance yield and commercial production of *Pleurotus eryngii* in Kashmir.

LITERATURE CITED

1. Koundal, Ritika, Kumar S. 2024. An economic analysis of production of button mushroom in Solan district of Himachal Pradesh, India. *Journal of Experimental Agriculture International* 46(7): 822-827. https://doi.org/10.9734/jeai/2024/v46i72635.
2. Kangotra A, Chauhan SK. 2014. Economic viability of button mushroom cultivation in Himachal Pradesh, India. *Indian Journal of Agricultural Research* 48(2): 134-139.
3. Atila F. 2017. Evaluation of suitability of various agro-wastes for productivity of *Pleurotus djamor, Pleurotus citrinopileatus* and *Pleurotus eryngii* mushrooms. *Journal of Experimental Agriculture International* 17: 1-11.
4. Chang ST, Miles PG. 1992. Mushroom biology: A new discipline. *Mycologist* 6: 64-65.
5. Singh A, Saini RK, Kumar A, Chawla P, Kaushik R. 2025. Mushrooms as nutritional powerhouses: A review of their bioactive compounds, health benefits, and value-added products. *Foods* 14(5): 741. doi: 10.3390/foods14050741.
6. Singh R. 2017. A review on different benefits of mushroom. *IOSR Journal of Pharmacy and Biological Sciences* 12(1): 107-111. doi: 10.9790/3008-120102107111.
7. Ukwuru MU, Muritala A, Eze LU. 2018. Edible and non-edible wild mushrooms: Nutrition, toxicity and strategies for recognition. *Journal of Clinical Nutrition and Metabolism* 2: 2.
8. Singer R. 1986. *The Agaricales in Modern Taxonomy*. Vol. 4, pp. 174-179. Koeltz Scientific Books, Berlin.
9. Moonmoon MM, Uddin N, Ahmed S, Shelly NJ, Khan MA. 2010. Cultivation of different strains of king oyster mushroom (*Pleurotus eryngii*) on sawdust and rice straw in Bangladesh. *Saudi Journal of Biological Sciences* 17: 341-345.
10. Ryu J, Kim MK, Im CH, Shin P. 2015. Development of cultivation media for extending the shelf life and improving yield of king oyster mushrooms (*Pleurotus eryngii*). *Scientia Horticulturae* 193: 121-126.
11. Zervakis G, Philippoussis A, Ioannidou S, Diamantopoulou P. 2001. Mycelium growth kinetics and optimal temperature conditions for the cultivation of edible mushroom species on lignocellulosic substrates. *Folia Microbiologica* 46: 231-234.
12. Lewinsohn D, Wasser SP, Reshetnikov SV, Hadar Y, Nevo E. 2002. The *Pleurotus eryngii* species-complex in Israel: Distribution and morphological description of a new taxon. *Mycotaxon* 81: 51-67.

13. Cangy C, Peerally A. 1995. Studies of *Pleurotus* production on sugar cane bagasse. *African Journal of Mycology and Biotechnology* 3: 67-79.
14. Torng PJ, Ming LC, Fung TY. 2000. Effect of rice bran on the production of different king oyster mushroom strains during bottle cultivation. *Journal of Agricultural Research of China* 49: 60-67.
15. Philippoussis A, Zervakis G, Diamantopoulou P. 2001. Bioconversion of agricultural lignocellulosic wastes through the cultivation of the edible mushrooms *Agrocybe aegerita*, *Volvariella volvacea* and *Pleurotus* spp. *World Journal of Microbiology and Biotechnology* 17: 191-200.
16. Ohga S, Royse DJ. 2004. Cultivation of *Pleurotus eryngii* on umbrella plant (*Cyperus alternifolius*) substrate. *Journal of Wood Science* 50: 466-469.
17. Okano K, Fukui S, Kitao R, Usagawa T. 2007. Effects of culture length of *Pleurotus eryngii* grown on sugarcane bagasse on in vitro digestibility and chemical composition. *Animal Feed Science and Technology* 136: 240-247.
18. Kirbag S, Akyüz M. 2008. Effect of various agro-residues on growing periods, yield and biological efficiency of *Pleurotus eryngii*. *Journal of Food, Agriculture and Environment* 6: 402-405.
19. Mandeel QA, Al-Laith AAA, Mohamed SA. 2005. Cultivation of oyster mushrooms (*Pleurotus* spp.) on various lignocellulosic wastes. *World Journal of Microbiology and Biotechnology* 21: 601-607.
20. Sabaratnam V, Kah-Hui W, Naidu M, David PR. 2013. Neuronal health - Can culinary and medicinal mushrooms help? *Journal of Traditional and Complementary Medicine* 3: 62-68.
21. Alam N, Amin R, Khan A, Ara I, Shim MJ, Lee MW, Lee TS. 2008. Nutritional analysis of cultivated mushrooms in Bangladesh: *Pleurotus ostreatus, Pleurotus sajor-caju, Pleurotus florida* and *Calocybe indica*. *Mycobiology* 36: 228-232.
22. Cheung LM, Cheung PCK, Ooi VEC. 2003. Antioxidant activity and total phenolics of edible mushroom extracts. *Food Chemistry* 81: 249-255.
23. Wasser SP, Weis AL. 1999. Medicinal properties of substances occurring in higher Basidiomycetes mushrooms: Current perspectives (review). *International Journal of Medicinal Mushrooms* 1: 31-62.
24. Maheshwari SK, Nazir A, Bhat MA, Beig SDM, Kounser S. 2007. Effect of agro-wastes on spawn run, pinhead formation and yield of oyster mushroom (*Pleurotus flabellatus*) in Kashmir. *Journal of Mycology and Plant Pathology* 37: 375-376.
25. Gregori A, Švagelj M, Pohleven J. 2007. Cultivation techniques and medicinal properties of *Pleurotus* spp. *Food Technology and Biotechnology* 45: 238-249.
26. Akyüz M, Yıldız A. 2007. Cultivation of *Pleurotus eryngii* on agricultural wastes. *Philippine Agricultural Scientist* 90: 346-350.
27. Mejía SJ, Albertó E. 2013. Heat treatment of wheat straw by immersion in hot water decreases mushroom yield in *Pleurotus ostreatus*. *Revista Iberoamericana de Micología* 30: 125-129.
28. Fan L, Pandey A, Mohan R, Soccol CR. 2000. Use of various coffee industry residues for the cultivation of *Pleurotus ostreatus* in solid state fermentation. *Acta Biotechnologica* 20: 41-52.
29. Ram RC, Pant DC. 2004. Effect of different amounts of spawn on spawn run period. *Indian Journal of Plant Pathology* 22: 131.
30. Peng JT. 1996. The cultivation of *Pleurotus eryngii* (DC.: Fr.) Quél. on rice straw substrate. *Journal of Agricultural Research of China* 45(4): 382-387.
31. Isikhuemhen OS, Mikiashvili NA, Kelkar V. 2009. Application of solid waste from anaerobic digestion of poultry litter in *Agrocybe aegerita* cultivation: mushroom production, lignocellulolytic enzymes activity and substrate utilization. *Biodegradation* 20: 351-361. https://doi.org/10.1007/s10532-008-9226-y
32. Öztürk C, Atila F. 2021. Changes in lignocellulosic fractions of growing substrates during the cultivation of *Hypsizygus ulmarius* mushroom and its effects on mushroom productivity. *Scientia Horticulturae* 288: 110403. https://doi.org/10.1016/j.scienta.2021.110403
33. Shen M, Lv G, He W, Wang N, Wang R, Quan X, Yuan Y, Yao X. 2026. From waste to wealth: effects of nine agroforestry wastes on Stropharia's traits and yield. *Open Life Science* 21(1): 20251189. doi: 10.1515/biol-2025-1189.
34. Miah MN, Begum A, Shelly NJ, Bhattacharjya DK, Paul RK, Kabir MH. 2017. Effect of different sawdust substrates on the growth, yield and proximate composition of white oyster mushroom (*Pleurotus ostreatus*). *Bioresearch Communications* 3(2): 397-410.