EFFECT OF SUBSTRATE AND SPAWN RATE ON THE GROWTH PARAMETER, YIELD AND BIOLOGICAL EFFICIENCY OF PLEUROTUS SAJOR-CAJU

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ABSTRACT

The oyster mushroom, Pleurotus sajor-caju was cultivated on paddy straw with different amount of weight substrate weight using wheat grain spawn at different rates. The spawning was done by sterilization of substrate. The bags were kept in mushroom growing room with the maintenance of temperature and humidity 20˚c-30˚c and 60-95 % respectively. The minimum days requires for completion of spawn run (14.33 days), primordial formation (17.33) and pinhead formation (20.33) was first observed on spawn rate of 150 gm with substrate of 3 kg on wet weight basis. Which was followed by spawn run (15.67 days), primordial formation (18.33 days) and pinhead formation (20.67 days) in treatment with 150gm spawn and 4 kg of substrate. Maximum Stem length and cap diameter was also higher in treatment with spawn rate of 150 gm with 3 kg of substrate. The maximum yield on fresh weight basis and biological efficiency was also found to be as the same treatment of 3 kg of substrate and 150 gm of spawn. Total soluble protein (16.5 %) and crude fiber (11.9 %)was also in considerable amount in Pleurotus sajor-caju when cultivated on paddy straw as substrate.

Key words: Pleurotus sajor-caju, Paddy straw, Spawn

1. Introduction:

The Pleurotus species also called as “Oyster mushrooms” or Dhingri now ranks second among the cultivated mushrooms in world (Chang and Miles, 1991). For

many reasons the fungi of the Pleurotus genus have been intensively studied in many different parts of the world; they have high gastronomic value. They are able to colonize and degrade a large variety of lignocellulosic residues, they require shorter growth time when compared to other edible mushrooms, they demand few environmental controls, their fruiting bodies are not very often attacked by diseases and pests and they can be cultivated in a simple and cheap way (Patrabansh and Madan, 1997). P. sajor-caju is one of the most successfully cultivated species of these mushrooms and it is considered to be delicious (Zhang et al., 2002). It is a cellulose loving fungus and grow naturally in the temperate and tropical forests on dead and decaying wooden logs or sometimes on drying trunks of deciduous or coniferous woods. It may also grow on decaying organic matter. The fruit bodies are small, grow singly or sometimes in clusters, oyster shaped, sometimes infundibuliform, greyish brown, stalk white and gills running down to stalk.(Cultivation of oyster mushroom). Most of all, Pleurotus spp. can utilize various kinds of substrate materials than any other mushrooms. Pleurotus species require a temperature of 20-30°C both for its vegetative growth and reproductive phase in natural habitat. (Chang et al.,2004). In India, paddy and wheat straw were used for commercial production of oyster mushroom (Jain and Vyas, 2002). Paddy straw proved to be best substrate for cultivation of oyster mushroom (Bano and Shrivastava, 1962; Bonatti et. al, 2004). The importance of edible mushrooms has increased due to the advances in cultivation technology, which makes the use of agricultural and industrial residues possible by recycling them as substrates for cultivation, consequently resulting in low-cost production and a continuous market (Eira, 2004). Moreover, they represent an excellent alternative for discarding several residues, helping in reducing pollution caused by the presence of these materials in the environment (Pandey et al., 2000). It is known that environmental factors

like temperature, humidity, type of substrates, stage of fruit-body development and post harvest storage affect the composition of mushrooms (Rai at al, 1988).

2. Materials and methods:

2.1 Culture and spawn preparation: A pure culture was maintained on Potato Dextrose Agar medium in test tubes at the temperature range between 12.1° c- 20.0° c. Clean whole grains of wheat were taken for the purpose.Grains were washed in clean water 3 times to remove dust and other impurities. The grains were then socked in water for 24 hours for absorption of water. Socked grains were again washed and boiled in water for 20-30 min (Jain, 2005), drained and put into flask with 2% Calcium carbonate powder, plugged with non absorbent cotton and then sterilized in autoclave at 22 Lb pressure for 1.5-2 hours. The grains were allowed to cool in room temperature for over night. Next day flasks were inoculated with agar medium colonized with the mycelium of pure cultures. About 8-10 days after inoculation, flasks were shaken vigorously. About three weeks after incubation, grain culture becomes ready for further multiplication of spawn. Inoculated flasks were incubated at 25±2°C.

2.2 Substrate preparation and cultivation: Paddy straw was taken as substrate and it had been chopped in to small pieces. The chopped substrates were steeped in water containing 75 ppm bavistin + 500 ppm formaldehyde for 18 hours (Jain, 2005) to prevent contamination by other fungi. After draining off excess solution, the steeped substrates were allowed to dry in sunlight to maintained final moisture content about 65-70 % by putting substrate in palm to ensure no drops of solution came out. Three different weight of substrate (media) M_1 (2 kg substrate), M_2 (3 kg substrate), M_3 (4 kg substrate) and three different weight spawn S_1 (50 gm.), S_2 (100 gm.), S_3 (150 gm.) were used in this experiment. Spawning is done by layer spawning in polypropylene bag of 18*24 inch size on wet weight basis with three replication. Each bag were labelled and transfer to mushroom cultivation room. Temperature and humidity

were maintained 20° c-30° c and 60-95 % respectively. Daily temperature and humidity were recorded and humidity was maintained by spraying water on gunny bags inside the mushroom shad. The experiment was laid out as factorial completely randomised design with three replication and nine treatments. The growth development and any changes in mushroom bag observed daily. The time taken for spawn run, primordial formation, pinhead formation, stipe length, cap diameter, the weight of fresh mushroom was recorded after harvesting of each three flush. Biological efficiency of mushroom on fresh weight basis was calculated by using formula given by Chang and Miles (1989).

2.3 Nutritional analysis.

After harvesting mushroom were sun dried and examined for nutritional analysis. Moisture, total soluble protein, nitrogen, total fat, total carbohydrate, reducing sugar, non reducing sugar, crude fiber, dietary fiber, ash, β- carotene were determined with procedure oven dry method, folin lawry method, micro kjehldalh method, soxhlet method, phenol sulphuric metod, DNSA(Dintro salisilic acid metod), DNSA(Dintro salisilic acid metod), acid alkali washing method, sigma kit, muffle furnace method, acetone extraction method respectively described by Sadasivam and manickamm(1992)

3. Result and discussion:

Table 1: Effect of spawn and substrate rate on growth parameter of Pl. Sajor-caju

Treatments	Spawn run (days)	Primordia formation (days)	Pinhead formation (days)	Stem length (cm)	Cap diameter (cm)
M_1S_1	20.00	22.33	25.00	2.29	6.01
M_1S_2	19.33	22.00	25.00	2.41	6.85
M_1S_3	18.67	21.67	24.33	2.53	6.54
M_2S_1	19.33	22.00	24.67	2.50	6.73
M_2S_2	16.00	19.00	21.67	2.73	6.83
M_2S_3	14.33	17.33	20.33	3.22	7.17

M_3S_1	19.67	22.33	25.00	2.33	6.83
M_3S_2	17.67	21.67	24.00	2.55	6.93
M_3S_3	15.67	18.33	20.67	3.00	6.95
S.E.M	0.52	0.58	0.57	0.07	0.25
CD	1.55	1.72	1.68	0.21	0.74
CV %	5.06	4.82	4.19	4.75	6.37

3.1. Spawn Running

Significant results were observed among treatments in terms of days taken for spawn running. These species behaved drastically on different amount of growing substrate in completing their mycelial growth. M_2S_3 took minimum number of days 14.33 ± 1.55 whereas treatments M3S3 (15.67 ± 1.55) showed at par result with M_2S_3 treatment. M_1S_1 (20.00 ± 1.55) took maximum days for completion of spawn run, which was followed by M_3S_1 (19.67 ± 1.55) (Table 1). The result for spawn running, primordial formation and fruiting body formation was found between 17-19 days, 21-23 days,25-27 days for Pl.sajor-caju on paddy straw as a substrate, Shauket et al.,2012.

3.2. Primordia formation

Treatments showed significant results in terms of days taken for emergence of primordia after completion of mycelial growth. M_2S_3 took minimum number of days 17.33 ± 1.72 whereas treatments M_3S_3 (18.33 ± 1.72) and M_2S_2 (19.00 ± 1.72) showed at par result with M_2S_3 treatment. M_1S_1 and M_3S_1 (22.33 ± 1.72) took maximum days for completion of primordial formation (Table 1).

3.3. Pinhead formation

Significant results were observed among treatments in terms of days taken for pinhead formation. M_2S_3 took minimum number of days 20.33 ± 1.68 whereas treatments M_3S_3 (20.67 ± 1.68) and M_2S_2 (21.67 ± 1.68) showed at par result

with M_2S_3 treatment. M_1S_1, M_1S_2 and M_3S_1 showed maximum days i.e. 25.00 ± 1.68 (Table 1).

3.4. Stem length

There was a significant result in length of fruit body. M_2S_3 (3.22 ± 0.21) showed maximum stem length which was at par with M_3S_3 (3.00 ± 0.21). Lowest stem length of fruit body was observed in M_1S_1 (2.29 ± 0.21) (Table 1). The large sized fruit bodies are considered to be of good quality and rated highly in mushroom production but this as an inferior quality since such fruit bodies tend to break during packaging thereby reducing their quality (B. O. Onyango et al, 2011).

3.5. Cap diameter

Cap diameter showed non significant result but from the table we can see that numerically M_2S_3 showed highest cap diameter i.e. 7.17 cm followed by M_3S_3 (6.95) and M_3S_2 (6.93) (Table 1).

Table 2: Effect of spawn and substrate rate on yield and biological efficiency parameter of Pl. Sajor- caju

Treatments	1st harvest (gm)	2nd harvest (gm)	3rd harvest (gm)	Total yield (gm)	Biological efficiency (%)
M_1S_1	334.67	250.00	161.00	745.67	98.13
M_1S_2	380.33	297.33	209.33	887.00	106.25
M_1S_3	481.67	365.00	255.33	1102.00	142.63
M_2S_1	415.33	362.67	306.67	1084.67	94.00
M_2S_2	528.67	430.00	336.67	1295.33	112.25
M_2S_3	733.33	615.67	403.67	1752.67	148.50
M_3S_1	324.00	266.67	213.33	804.00	51.31
M_3S_2	498.67	426.67	344.33	1269.67	79.38
M_3S_3	654.00	528.33	451.00	1633.33	105.81

S.E.M	22.67	19.49	17.03	40.33	3.74
CD	67.35	57.90	50.59	119.83	11.10
CV %	8.12	8.58	9.90	5.95	6.34

3.6. Total yield and biological efficiency of Mushroom

The treatment results (Table 2) reveal the yield, biological efficiency (B.E.) of the P. sajor-caju.. Significantly maximum gram of yield of P. sajor-caju was obtained when it was cultivated on 2 kg of paddy straw i.e. M_2S_3 (1752.67 ± 119.83) and M_3S_3 (1633.33 ± 119.83) which was at par with M_2S_3. The maximum B.E., with 148.50 % was observed in M_2S_3 and M_1S_3 (142.63 %) which was at par with M_2S_3, whereas lowest gram of yield was recorded in M_1S_1 745.67 ± 119.83 which was followed by M_3S_1 (804.00 ± 119.83). The lowest B.E., was observed in M_3S_1 (51.31 %), which was followed by M_3S_2 (79.38%)(Table 2). According to Chang and Miles (1982), BE of *P. sajor-caju* can be increased to nearly 100% depending on the composition of the substrate. These Pleurotus sajor-caju significantly on different amount of substrate with different amount of spawn. Kibar and Peksen (2008) recorded effect of temperature and light intensity on the development and yield of different Pleurotus species. About similar result was found by Pandey et al., 2008 in their experiment maximum yield of pleurotus sajorcaju (1733.60 g/bed) was recorded on paddy straw(Table.1 and 2), which was at par with wheat straw (1627.49 g/bed)

Table 3: Nutritional content of Pleurotus sajor-caju

Sr. No.	Parameter	Content
1	Moisture (%)	7.7
2	Total soluble protein (%)	16.5
3	Nitrogen (%)	4.1
4	Total fat (%)	2.5
5	Total carbohydrate (%)	38.5
6	Reducing sugar (%)	23.5
7	Non reducing sugar (%)	14.9

8	Crude fiber (%)	11.9
9	Dietary fiber (%)	12.5
10	Ash (%)	4.7
11	β- carotene(µg/g).	0.35

3.7. Nutritional content

Moisture, total soluble protein, nitrogen, total fat, total carbohydrate, reducing sugar, non reducing sugar, crude fiber, dietary fiber, ash, β- carotene content of mature fruiting bodies of P.sajor-caju cultivated on paddy straw as substrate are shown in Table 3. Moisture content of mature sundried sample of P. Sajor-caju was (7.7%), total soluble protein (16.5%), Moisture, nitrogen (4.1%), total fat(2.5 %), total carbohydrate (38.4 %), reducing sugar(23.5 %), non reducing sugar (14.9 %), crude fiber (11.9 %), dietary fiber (12.5 %), The result of crude fiber is similar with Arun et al., 2010., ash (4.7 %), β- carotene(0.35 µg/g). Syred et al, (2003) also confirmed that protein content of mushroom is the highest among vegetables. The observation made in their fibre content are equally note worthy and stimulating as fibre content help to facilitate digestion in man. (Onuoha,2007).The percentage fat content from the mushroom produced by the substrates is an evident that mushrooms are low in fat and cholesterol (Syred et al, 2003).

4. Conclusion

The present study shows cultivation of Pl. Sajor-caju generally depends on different parameters like use of substrate, amount of substrate and spawn, environmental conditions like maintenance of temperature and humidity during cropping. As per this experiment it has been observed that use of spawn at different rate of substrate yield and biological efficiency may be differing case to case. By focusing on treatment combination of different amount of substrate and spawn in our experiment M_2S_3 treatment which contain 3 kg of wet

substrate and 150 gm of spawn proved to be highest yield and biological efficiency. And M_3S_3 treatment which contain 4 kg of wet substrate and 150 gm of spawn proved to be equally effective for successful cultivation of Pl.sajor-caju mushroom.

References

1. B. O. Onyango, V.A Palapala, P. F. Arama, S. O. Wagai, B. M. Gichimu. (2011)Suitability of selected supplemented substrates for cultivation of Kenyan native wood ear mushrooms (Auricularia auricula), American Journal of Food Technology, Vol.6, 395–403.
2. Bano Z. and Srivastava H.C. (1962). Studies on cultivation of Pleurotus species on paddy straw. Food Sci. 12: 363- 365.
3. Bonatti M., Karnopp P., Soares H.M., and Furian S.A. (2004). Evaluation of Pleurotus ostreatus and Pleurotus sajor-caju nutritional characteristics when cultivated in different lignocellulosic wastes. Food Chem. 88(3):425-428.
4. Chang, S. T and P. G. Miles. 1982. Introduction to Mushroom Science. *In:* S. T. Chang and T. H. Quimio (eds). *Tropical Mushrooms: Biological Nature and Cultivation methods.* The Chinese University Press. 3-10.
5. Chang, S.T and Miles, P.G (1991). Cultivation of edible mushrooms. Chung Chi, J. Hongkong. 4: 76-86.
6. Change, S.T. and Miles, P.G. (1989). Edible Mushroom and their Cultivation, CRC Press, Boca Raton, Florida, U.S.A.
7. Cultivation of oyster mushroom, published by: Director, National center for mushroom research and training, Chambaghat, solan-173 213, Himachal Pradesh,(India)

8. Eira AF (2000) Cultivo de cogumelos (composta- gem, condução e ambiente). In Reunião Itiner- ante de Fitossanidade do Instituto Biológico. Mogi das Cruzes, SP, Brazil. Resumos. pp.71-81.
9. Jain A.K. and Vyas D. (2002). Yield response of P. florida on wheat straw in combination with other substrates.
10. Jain, A.K. (2005). Studies on cultivation technology of Pleurotus species and their marketing potential in Sagar region (Ph.D. thesis).
11. Jawad Ashraf, Muhammad Asif Ali, Waqas Ahmad, Chaudhry Muhammad Ayyub, Jamil Shafi.(2013). Effect of Different Substrate Supplements on Oyster Mushroom (Pleurotus spp.) Production , . Food Science and Technology 1(3): 44-51, 2013 http://www.hrpub.org DOI: 10.13189/fst.2013.010302
12. Kibar B., Pekien, A. Modelling (2008). Modelling the Effects of temperature and light intensity on the development and yield of different Pleurotus species Agricultura Tropica ET Subtropica. 41: 68 -73.
13. M.I. Bhatti, M.M. Jiskani, K. H. Wagan, M.A. Pathan and M.R. Magsi, (2007) Growth, development and yield of Oyster mushroom, Pleurotus ostreatus (jacq.ex.fr.) kummer as affected by different spawn rates. Pak. J. Bot., 39(7): 2685-2692,.
14. Onuoha C.I (2007): Cultivation of mushroom (Pleurotus tuber regium) using some local substrates. Life science journal .Vol 4 (4):58-61.
15. Pandey A, Soccol CR, Nigam P, Brand D, Mohan R, Roussos S (2000) Biotechnological potential of coffee pulp and coffee husk for bioprocesses. Biochem. Eng. J. 6: 153-162.
16. Pandey R. K, I. B. Pandey, S. Jha.(2008). Performance of oyster mushroom Plurotus sajor caju on different agricultural waste. 3-4 (67-68)

17. Patrabansh, S., and Madan, M. (1997). Studies on cultivation, biological efficiency and chemical analysis of Pleurotus sajor-caju (Fr.) Singer on different biowastes. Acta Biotechnologica. 17: 107-122.
18. Rai. R.D., S. Saxena, R.C. Upadhyay and H.S. Sohi. (1988). Comparative nutritional values of various Pleurotus species grown under identical conditions. Mush. J. Tropics. 8(3): 93-98.
19. S.T. Chang, P. G. Miles (2004), Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact (IInd edition), CRC Press, New York,
20. Shauket Ahmed Pala, Abdul Hamid Wani and Riyaz Ahmed Mir. (2012). Yield performance of Pleurotus sajor- caju on different agro-based waste**s.** Annals of Biological Research, 3 (4):1938-1941
21. Syred, A.A., Kadam, J. A., Mane, V. P., Patil, S. S., and Baig, M. M. (2003): Biological efficiency and nutritional contents of Pleurotus florida (Mont.) Singer cultivated on different agro- wastes. Nature and Science Journal.Vol 7(1): 44-48.
22. Zhang R, Xiujin L, Fadel JG (2002). Oyster mushroom cultivation with rice and wheat straw. Biores. Technol., 82:277-284.