Biological Efficiency And Nutritional Contents Of *Pleurotus florida* (Mont.) Singer Cultivated On Different Agro-wastes

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ABSTRACT:
Pleurotus florida (Mont.) Singer was cultivated on different agro-wastes viz. soybean straw, paddy straw, wheat straw and their combination in 1:1 proportion to determine the effect of these agro waste on yield, moisture content, crude protein, total carbohydrates, fat, crude fiber, ash and minerals like Ca, P, Fe content. Soybean straw showed significantly highest yield (with 87.56% B.E.) with maximum crude protein (23.50%) and maximum phosphorus (920 mg/ 100 mg of dry mushroom) content. Maximum moisture (92.45 %) and crude fiber content (8.10%) in the fruiting bodies was recorded on Paddy straw cultivation. The combination of Soybean straw + paddy straw showed significantly highest fat (2.60%), Calcium (310 mg/ 100gm) and Iron (13.06 mg/100gm of dry mushroom) content. [Nature and Science. 2009;7(1):44-48]. ISSN: (1545-0740).

Keywords: *Pleurotus florida*, B.E. (Bio efficiency), agro-waste, fruiting body.

INTRODUCTION

Mushrooms are rich in proteins, vitamins, and minerals and popularly called as the vegetarian's meat. Mushroom proteins are considered to be intermediate between that of animals and vegetables (Kurtzman, 1976) as it contains all the nine essential amino acids required for human body (Hayes and Haddad, 1976).

Oyster mushroom (i.e. *Pleurotus spp*.) is commonly called as Dhengri in India because of its oyster like shape. Genus *Pleurotus* belongs to family Tricholomataceae and has about 40 well-recognized species, out of which 12 species are cultivated in different parts of country. *Pleurotus* is an efficient lignin-degrading mushroom and can grow well on different types of lignocellulolosic materials. Cultivation of this Mushroom is very simple and low cost production technology, which gives consistent growth with high biological efficiency. Different species of *Pleurotus* can grow well in variable temperature conditions; hence they are ideally suited for cultivation throughout the year in various regions of tropical country like India.

In the recent times, the cultivation of *Pleurotus sp*. had excelled next to *Agaricus bisporus* (Lange) Sıng. throughout the world in terms of yield and production (Erkel, 1992; Chang *et al.,* 1991). Among the *Pleurotus sp., P.sajor caju* had been widely studied for the cultivation followed by *P. ostreatus* . These studies mainly concentrated on the cultivation on wastes of forest and agricultural plants. Almost, all the available, lignocellulosic substances are likely be used as substrate for *Pleurotus sp*. Cultivation with slightly variation in the range and combination of the substrates in different part of world based on their availability in abundant and being cheaper in the respective region. (Royse, 1985; Schmidt, 1986). Most of these studies focused on the higher yield and quality of fruiting bodies of *Pleurotus sp.* with respect to cultivation times. The present study deals with the cultivation of *P. florida* on some common and abundantly available waste available for conversion in food which otherwise is left for natural degradation. The cultivation of edible mushrooms offers one of the most feasible and economic method for the bioconversion of agro-lignocellulosic wastes (Bano *et al.,* 1993; Cohen *et al.,*2002). The technology can also limit air pollution associated with burning agriculture wastes as well as to decrease environmental pollution due to unutilized agricultural wastes.

MATERIAL AND METHODS

Culture and cultivation:

The pure cultures of *Pleurotus florida* was obtained from National Collection of Industrial Micro organisms (NCIM No.1243), National Chemical Laboratory (NCL), Pune, India. The cultures were maintained on 2 % malt extract agar slants at 4º C. Sub culturing were done after every 15 days.

Spawn preparation:

Spawn was prepared in polythene packets. Sorghum whole grains were boiled in water bath for 10-15 min. at the ratio of 1:1 (Sorghum grains: water) and mixed with 4 % (w/w) $CaCO_3$ and 2 % (w/w) $CaSO_4$. Sorghum grains then packed (250g) in polythene bags (of 200x300 mm. size) and sterilized in an autoclave at 121ºC, for 30 min. After sterilization, the bags were inoculated with actively growing mycelium of the *Pleurotus* from malt extract slants and incubated (at 27 ± 2 ºC) for mycelial growth without any light for 10-15 days until the mycelium fully covered the grains.

Cultivation:

The agro waste soybean straw, wheat straw, paddy straw were collected from local farms and were used for filling the bags. Soybean straw, paddy straw, wheat straw and their combination in 1:1 proportion were used as a cultivation substrates, following the method prepared by Bano and Shrivastava (1962) with slight modifications. The substrates were chopped to 2-3 cm pieces and soaked in water over night to moisten it and excess water was drained off. After soaking, the substrate was steam sterilized at 121º C for 20 min. in an autoclave. The polythene bags of the size 35 x 45 cm were filled with sterilized substrates and multi layered technique was adopted for spawning. Each bag was filled with 1 Kg dry substrate and the spawn was added at the rate of 2 % of the wet weight basis of substrate.

After inoculation the bags were kept in house where the temperature and humidity were maintained around 25 ºC and 80 to 90% respectively with sufficient light and ventilation for 20 days. The spawn run was completed within 18 days. The polythene bags were tear-off following the spawn run. Formation of fruit bodies was evident within 3-4 days after removal of poly bags. The beds were maintained up to the harvest of the third flush, which was completed in 35 days after spawning. A small layer of substrate was scrapped off from all the side of the beds after each harvest. Each of the six treatments was replicated three times.

Yield and biological efficiency:

Total weight of all the fruiting bodies harvested from all the three pickings were measured as total yield of mushroom. The biological efficiency (yield of mushroom per kg substrate on dry wt. basis) was calculated by the following formula Chang *et al.,* (1981)

$$\text{B.E. (\%)} = \frac{\text{Fresh weight of mushroom}}{\text{Dry weight of substrate}} \times 100$$

Moisture content:

The moisture content of mushroom was also expressed in percent and calculated by the formula –

$$\text{Moisture content (\%)} = \frac{\text{Weight of fresh sample} - \text{weight of dry sample}}{\text{Weight of fresh sample}} \times 100$$

***Nutritional analysis*:**

Protein, fat, ash and total carbohydrate were determined with the procedure recommended by AOAC (1995) and Wankhede *et al.,* (1976). The crude fibers and calcium was determined with procedure recommended by Ranganna (1986). The iron and phosphorus content were estimated according to the procedure given in Laboratory manual of NIN (Anonymous, 1980). The recorded data in the present work was subjected to statistical analysis as per the procedure given by Panse and Sukhatme (1978).

RESULT AND DISCUSSION:

The results reveal the yield, B.E. and moisture content of the *P. florida* cultivated on different agro-wastes alone or in combination (Table 1). The maximum yield of *Pleurotus florida* was obtained when it was cultivated on soybean straw (875.66gm/kg straw) with 87.56% B.E., this was followed by yield on soybean + paddy straw (852.00gm/kg straw) with 85.20% B.E. while least was recorded with wheat straw+ paddy straw (723.66gm/kg straw). The moisture content was maximum on paddy straw (92.45%) followed by soybean + wheat straw (90.23%) there was slight variation with other substrate indicating that moisture content is independent of the substrate.

Comparing the three lignocellulosic residues as substrates for the cultivation of *P. florida* shows that soybean straw supported best growth of *P. florida* as evidenced by complete and heavy colonization of substrates forming a compact white mass of mycelium within 2 weeks of inoculation. Furthermore, the quantity of fresh edible fruiting bodies (g/kg of substrate) harvest was higher in single substrate than in mixed substrate. The performance of the three substrates was also evident by their elevated biological efficiency values on Soybean straw followed by paddy straw (Table 1). The time required for harvest of the fruiting bodies on soybean straw always preceded paddy straw alone or in combination.

Reports on cultivation of the oyster mushroom on similar by-products have manifested variable levels of B.E. These variations are mainly related to spawn rate, fungal species used and supplement added to the substrate (Mane *et al.*, 2007). Some of the elevated B.E. of *Pleurotus sp.* on commonly used substrates rice straw 85.5% (Mehta *et al.* 1990), leguminous plants 103.8% (Sharma and Madan 1993).

The Protein, fat, carbohydrate, crude fibre, ash and Ca, P, and Fe contents of mature fruiting bodies of *Pleurotus florida* cultivated on different lignocellulosic substrates alone or in combination are shown in Table 2. *P. florida* fruiting bodies produced on soybean straw possessed the highest protein content of 23.5 % on a dry weight basis followed by soybean + paddy straw (22.66%). The fat content of *P. florida* was 2.60 % grown on soybean + paddy straw being the highest followed by soybean straw alone (2.50%). The % content of protein and fat content were similar as reported in earlier studies (Patil *et al.,* 2008, Patil and Dakore, 2007).

Maximum Carbohydrate content of *P. florida* was 57.80% in fruiting bodies cultivated on soybean straw whereas least was 53.87% cultivated on wheat straw + paddy straw (Patil *et al.,* 2008,). The highest crude fibre was obtained on paddy straw (8.10%) followed by soybean straw (8.02%). Other agro waste alone or in combination also yielded appreciable level of crude fibre. These results were confirmed with findings of Bonatti *et al.* (2004), Khyadagi *et al.,* (1998), (Sharma & Madan 1993). Singh *et. al.*(2003). From the present study it is evident that, *Pleurotus florida* is the suitable species for cultivation on Soybean and Soybean + paddy straw in case of productivity and nutritional contents. The protein contents of various lignocellulosic residues were compared and it was reported that the nitrogen content in fruiting bodies was higher in leguminous plant substrates than non-leguminous ones (Sharma & Madan, 1993). These results were confirmed with the findings of Kadlag *et al.,* (1998) Mandhare (2000). The protein content usually ranges between 20–30% on a dry weight basis. Substrates rich in usable nitrogen after spawn run may be a factor in enhancing the mushroom yield and quality, in addition to the mushroom species in bioconversion and bioaccumulation efficiency (Patil *et al.,*2008).

The maximum ash content of *P. florida* was found on soybean straw (8.00%) followed by mushroom grown on paddy straw (6.60%). Similar results were reported by El –Kattan *et al.,* (1991). The highest calcium content in *P. florida* was recorded when it was grown on soybean straw + paddy straw (310 mg/100gm) followed by soybean straw(305 mg/100gm) alone. The phosphorus content in *P. florida* was maximum on soybean straw (920mg/100gm) whereas least was found on soybean straw +wheat straw (800 mg/100gm). Similar amount of phosphorus was also recorded in earlier study (Caglarirmak, 2007). Highest Iron content in *P. florida* when cultivated on soybean straw+ paddy straw was 13.06 mg /100 gm while least was recorded on the soybean straw +wheat straw (11.87 mg/100gm) These results coinced with those observed by Kikuchi *et al.,* (1884), Rathor and Thakore (2004).

Commercial production of oyster mushrooms is largely determined by the availability and utilization of cheap materials of which agricultural lingo-cellulosic waste represents the ideal and most promising substrates for cultivation. The substrates used in this study can be considered practical and economically feasible due to their availability throughout the year at little or no cost in large quantities. Utilization of these agro-wastes for the production of oyster mushrooms could be more economically and ecologically practical.

Table 1: Effect of different substrate on yield, Bio efficiency (B.E.) and moisture content of *Pleurotus florida.*

Substrate	Yield (gm/kg dry straw)			Total yield	B.E. (%)	Moisture (%)
	I st picking	II nd Picking	III rd Picking			
Soybean straw	412.00	365.66	98.00	875.66	87.56	89.55
Paddy straw	376.00	318.33	140.00	834.33	83.43	92.45
Wheat straw	352.00	263.62	135.00	750.62	75.06	89.40
Soybean + paddy straw	408.00	320.00	124.00	852.00	85.20	90.17
Soybean + wheat straw	362.66	248.00	172.00	782.66	78.26	90.23
Wheat + paddy straw	310.66	275.00	138.00	723.66	72.36	89.46
S.E. ±	10.60	13.17	7.73	-	-	0.22
C.D at 5%	33.34	41.43	24.32	-	-	0.69

Table 2: Effect of different substrate on Protein, Fat, Carbohydrate, Crude fiber, Ash and Minerals like Ca,
P, Fe, content of *Pleurotus florida*.

Substrate	Protein (%)	Fat (%)	Carbohydrate (%)	Crude fiber (%)	Ash (%)	Ca*	P*	Fe*
Soybean straw	23.50	2.50	57.80	8.02	8.00	305	920	12.38
Paddy straw	22.40	2.28	55.50	8.10	6.60	292	860	12.81
Wheat straw	21.33	2.30	56.00	7.80	6.40	287	820	12.28
Soybean + Paddy straw	22.66	2.60	54.90	7.56	6.50	310	840	13.06
Soybean + Wheat straw	22.40	2.30	57.10	7.50	6.35	275	800	11.87
Wheat + Paddy straw	20.25	2.28	53.87	7.40	6.50	304	830	12.92
S.E. ±	0.27	0.03	0.36	0.17	0.06	8.09	15.05	0.11
C.D. at 5%	0.87	0.11	1.16	0.54	0.19	25.46	47.36	0.35

*mg/100gm dry mushroom

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8/30/2008

REFERENCES:

1. Anonymous. A Practical Manual of Nutrition, NIN. National Institute of Nutrition, Hyderabad. 1980.
2. AOAC. Official methods of analysis. Association of official analytical chemists. 16th Ed., Arlington, VA. 1995.
3. Bano, Z., Shasirekha, M.N. & Rajarathnam, S. Improvement of the bioconversion and biotransformation efficiencies of the oyster mushroom (*Pleurotus sajor-caju*) by supplementation of its rice straw with oil seed cakes. Enzyme and Microbial Technology 1993; 15: 985–989.
4. Bano, Z., Srivastava, H.C. Studies in the cultivation of *Pleurotus* sp. on paddy straw. Food Sci., 1962; 12:363-368.
5. Bonatti, M., Karnopp, P., Soares, H.M., Furlan, S.A. Evaluation of *Pleurotus ostreatus* and *Pleurotus sajor-caju* nutritional characteristics when cultivated in different lignocellulosic wastes. Food Chem., 2004; 88(3): 425-428.
6. Chang, S. T., Miles P. G. Recent trends in World Production of Cultivated Edible Mushrooms. Mushr. Jour. 1991; 503; 15-18.
7. Chang, S.T.; Lau, O.W. and Cho, K.Y. The cultivation and nutritive value of *Pleurotus sojar –*

caju. European J. Appl. Microbiol. Biotechnol. 1981; 12:58 – 62.

8. Cohen, R., Persky, L. & Hadar, Y. Biotechnological applications and potential of wood degrading mushrooms of the genus *Pleurotus*. Applied Microbiology and Biotechnology. 2002; 58, 582–594.
9. El – Kattan, M.H.; Helmy, Z.A.; Abdel, H.; El – Leithy, M. and Abdelkawi, K.A. Studies on cultivation techniques and Chemical composition of Oyster mushrooms. Mushroom. J. for tropics. 1991; 11 (314): 59 – 66.
10. Erkel, I. Effects of Different Growing Medium on yield of *Pleurotus ostreatus* and *Pleurotus florida* Cultivation, Fourth Congress of Edible Mushroom of Turkey, 1992; Vol. I, pp. 8., Yalova.
11. Hayes, W.A. and Haddad, S.P. The nutritive value of mushrooms. Mushroom. J.1976; 30:204.
12. Kadlag, G.K.; Wani, P.V. and Sawant, D.M. Comparative performance of different *Pleurotus spp.* On wheat and green gram straw. Maharashtra Agric. Univ. 1998; 23 (1): 25 – 86.
13. Khydagi, K.S.; Sharda, G.S. and Meera Rao. Proximate composition of Oyster mushroom. Karnataka J. Agri. Sci. 1998; 11 (2): 548 – 549.
14. Kikuchi, M., Tamakawa, K., Hiroshima, K., Aihara, Y., Mishima, Y., Seki, T., Tsunoda, A. Survey on contents of metals in edible mushrooms. Journal of the Food Hygienic Society of Japan. 1984; 25(6) 534-542.
15. Kurtzman, R.H. Nitration of *Pleurotus sapidus* effects of lipid. Mycologia. 1976; 68: 268 – 295.
16. Mandhare, V.K. "Productivity of *Pleurotus sp.* On different substrates and its effect on Nutritional Indices of spent straw. Ph.D. Thesis. Marathwada Agricultural Univ., Parbhani. 2000.
17. Mane VP, Patil SS, Syed AA, Baig M.M.V. Bioconversion of low quality lignocellulosic agricultural waste into edible protein by *Pleurotus sajor-caju* (Fr.) Singer. J Zhejiang Univ Sci B. 2007; 8(10):745-51.
18. Mehta, V., Gupta, J.K. & Kaushal, S.C. Cultivation of *Pleurotus florida* mushroom on rice straw and biogas production from the spent straw. World Journal of Microbiology and Biotechnology 1990; 6, 366–370.
19. Çağlarırmak, Necla. The nutrients of exotic mushrooms (*Lentinula edodes* and *Pleurotus* species) and an estimated approach to the volatile compounds. Food Chemistry. 2007; 105(3): 1188-1194
20. Panse, V.G. and Sukhatme, P.V. Stat. Math. Agri. Work. ICAR. Publication, New Delhi. 1978.
21. Patil, S. S. and Dakore, H. G. Comparative study on yield performance and Nutritive value of oyster mushroom on soybean straw. *Bioinfolet*, 2007; 4(1): 57-59.
22. Patill S.S., Kadam R.M. Shinde S.L. and Deshmukh S.A. Effect of different substrate on productivity and proximate composition of *P. florida*. Int. J. Plant Sci. 2008; 3(1): 151-153
23. Ranganna, S. "Hand book of analysis and quality control for fruit and vegetable products" pp. 1986; 25 – 26.
24. Rathore, V. R. S., and Thakore, B. B. L. Effect of different substrates on the production and nutritional value of sporophores of *Pleurotus florida* (Eger) Nom. Nud. Journal of Mycology and Plant Pathology, 2004; 34(1): 66-68
25. Royse, D. J. Effects of spawn run time and substrate nutrition on yield and size of the shiitake mushroom, Mycologia, 1985; 75(5): 756-762.
26. Schmidt, O. Experiments with Mushroom Cultivation on Wood Waste, Plant Research and Development 24, 1986; pp. 85-92.
27. Sharma, S. & Madan, M. Microbial protein from leguminous and non-leguminous substrates. Acta Biotechnologica. 1993; 13: 131–139.
28. Singh, N.I.; Singh, T.C. and Devi, M.B. Nutritional composition, processing and preservation of the edible mushroom found in Manipur for sustainable economic development. J. Mycological research. 2003; 41 (2): 243 – 244.
29. Wankhede, D.B. and Tharanthan, R.N. Sesame (*Sesamum indicum*) carbohydrates. J. Agri. Food chem. 1976; 24: 655 – 659.