International Journal of Botany Studies
www.botanyjournals.com
ISSN: 2455-541X
Received: 05-10-2021, Accepted: 18-10-2021, Published: 06-11-2021
Volume 6, Issue 6, 2021, Page No. 138-141

Nutritional content of oyster mushroom and recycling of soybean spent straw

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Abstract
Pleurotus eous was cultivated on soybean straw for analyzing the nutritional content of mushroom fruiting bodies and spent mushroom straw (SMS). Results showed the maximum moisture (86.10 to 88.70 %), total carbohydrate (53.70 to 57.90 %), protein (23.00 to 26.50 %), fat (2.10 to 2.86 %), crude fibre (6.50 to 7.90 %) and ash (6.50 to 8.10 %) content in mushroom fruiting bodies. The mushroom spent straw showed an increase in protein (3.50 to 5.90 %), ash (7.40 to 9.30 %) and moisture (6.90 to 8.15 %) content while a decrease in pH (7.10 to 5.4o%), Crude fiber (40.30 to 23.00 %), total carbohydrates (80.10 to 52.50 %), lignin (29.80 to 12.50 %), cellulose (39.10 to 27.50 %), hemicellulose (21.80 to 08.70 %) and tannin (37.20 to 24.30 %) content as compare to soybean straw. During spawn run period, lignin degradation was faster and during fruiting bodies formation, lignin degradation was slowed down while degradation of cellulose and hemicellulose in straw was faster in rate during fruiting bodies formation.

Keywords: SMS, soybean straw**,** *Pleurotus eous*

Introduction

Mushroom growing is an ecofriendly activity as it utilizes the waste from agriculture, horticulture, poultry, brewery etc. for its cultivation. Plant waste is the basic substrate utilized for cultivation of different edible mushrooms. *Pleurotus* mushroom became more popular and widely cultivated in the world as they can degrade large insoluble contents of lingo cellulosic materials and hence play a key role in their bioconversion into foods and dietary supplements (Bisaria *et al.*, 1987, Zhang, Li, & Fadel, 2002) [4, 36]. These lingo cellulosic materials are generally low in nutritional content.

In mushroom growing regions, the spent mushroom substrate (SMS), is generated in large quantity as 1 kg of fresh mushrooms brings nearly 5 kg of a spent substrate (Finney *et al*. 2009) [11]. The traditional methods of disposal of SMS without any use are neither eco-friendly nor economic (Oei *et al*. 2007; Carrasco *et al*. 2018) [23, 8] which may cause a various environmental problems including ground water contamination, air pollution and nuisance (Beyer, 1996). Therefore, it is necessary to adopt new methods for the beneficial use of SMS in improved applications. The spent mushroom substrates have potential benefits in many fields, like soil-less growing medium (Medina *et al*., 2009; Ribas *et al.*, 2009) [22, 31], soil and water bioremediation (García-Delgado *et al.*, 2013; Jordan *et al.*, 2008; Lau *et al.*, 2003; Li *et al*., 2012) [13, 14, 18, 20], energy feed stocks (Finney *et al*., 2009) [11], animal feeds (Li *et al.*, 2001) [19] and organic amendments (Courtney and Mullen, 2008; Paula *et al*., 2017) [7, 28]. Pleurotus spent substrate has been evaluated as a bio fertilizers (Zhu *et al.*, 2013) [38]. Most of these applications are unable to solve the perfect disposal problem but only the use of SMS in agricultural is an economically and ecologically acceptable way (Paredes *et al.*, 2016) [27].

During last decade, the area under soybean crop has increased in this part of India and a huge quantity of biomass is produced after the cultivation of soybean. This soybean straw following harvest is used as animal feed (Zhu *et al.* 2008; Terashima *et al.* 2009) [37, 34]. Many studies have shown use of the soybean straw for cultivation of *P. sajor-caju* (Dehariya and Vyas, 2020; Mane *et al.*, 2007; Patil *et al.*, 2010) [9, 21, 35]. But even after harvest the nutritional status of the spent straw need to be investigated. Attempt were made to analyze the spent straw for use in animal feed with enhanced nutrition or application as soil conditioner following grinding of the spent straw. The present study evaluated the nutritional content of mushroom fruiting bodies and the soybean spent straw during and after cultivation of *P. eous* at different growth stages.

Material and Methods

Strains of mushroom

Pleurotus eous strain cultures were preserved on 2 % malt extract agar slants at 4º C. Sub-culturing were done after every 15 days interval.

Spawn preparation

Spawn was prepared in polythene packets. Sorghum grains were boiled in water bath for 10-15 min in the ratio of 1:1 (Sorghum grains: water) and mixed with 4% (w/w) $CaCO_3$ and 2% (w/w) $CaSO_4$. Sorghum grains were then packed (250g) in polythene bags (of 200x300 mm. size) and sterilized in an autoclave at 121 ^{0}C for 30 min. After sterilization, the bags were inoculated with actively growing mycelium of *P. eous* 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.

Experimental details

Experiment was conducted in Randomized block design with five replications.

Cultivation of mushroom

Soybean straw was used as cultivation substrates following the method described earlier (Patil and Baig, 2020) [30].

Chemical analysis

Analysis of moisture, protein, fat, crude fiber, total carbohydrates, ash, lignin, cellulose, hemicellulose and tannin of samples were done by standard methods (AOAC, 1995) [1].

Result and Discussion

Table 1: Effect of different substrates on nutritional content of *P. eous*.

Substrate	Moisture (%)	Total carbohydrate (%)	Protein (%)	Fat (%	Crude fibre (%	Ash (%)
Soybean straw	87.30	54.80	26.50	2.86	6.80	8.10
Paddy straw	88.10	55.80	25.50	2.10	7.90	6.80
Wheat straw	87.30	56.00	24.20	2.58	7.40	7.60
Jowar straw	88.70	57.90	24.70	2.20	7.70	7.80
Sunflower stalk	86.10	53.70	23.00	2.70	6.50	6.50
Bajra straw	87.10	55.20	24.30	2.15	7.80	7.50
S.E.+-	0.40	0.65	0.59	0.10	0.12	0.14
C.D. at 5%	0.86	2.31	1.60	0.18	0.28	0.42

Moisture, total carbohydrate, protein, fat, crude fiber and ash content of mature fruiting bodies of *P. eous* cultivated on different agro wastes are shown in Table 1. Moisture content of *P. eous* was found maximum when cultivated on (88.70 %) jowar straw, followed by (88.10 %) on paddy straw while least was found (86.10 %) on sunflower stalk. Carbohydrate content of *P. eous* was 57.90 % grown on jowar straw being the highest followed by (56.00 %) on wheat straw and minimum carbohydrate was reported 53.70 % on sunflower stalk. These results are confirmed with the findings of Patil (2017) [26]. Protein content of *P. eous* fruiting bodies grown on different substrates ranged from 23.00 to 26.50 %. Significantly maximum protein content of mushroom was 26.50 % in fruiting bodies cultivated on soybean straw while least was 23.00 % on sunflower stalk. These results are confirmed with the findings of Patil (2019). Maximum fat content of *P. eous* fruiting bodies was found (2.86 %) on soybean straw, and minimum fat content was found (2.10 %) on paddy straw. The % content of fat were similar as reported in earlier studies (Syed Abrar *et al*., 2009, Patil and Baig, 2020) [33, 30]. The crude fiber content of *P. eous* fruiting bodies was ranged from 6.50 to 7.90 % when grown on different substrates. Highest crude fiber content of *P. eous* was observed when mushroom grown on paddy straw (7.90 %), followed by on bajra straw (7.80 %) and least crude fiber was noticed when mushroom grown (6.50 %) on sunflower stalk. Ash content of *P. eous* fruiting bodies was 8.10 % grown on soybean straw being the highest followed by on jowar straw (7.80 %) and minimum ash content was recorded on (6.50 %) sunflower stalk. Telang *et al*. 2010 [35] reported maximum (08.00 %) crude fibre content on paddy straw and maximum ash content (07.00 %) in fruiting bodies of *Pleurotus sapidus* when grown on soybean straw. The variation in the nutritional content of mushroom might be due to the quality and quantity of nutrients available in the substrates.

Table 2: Chemical composition of soybean straw and soybean spent straw

Substrates	Un-autoclaved	Autoclaved	Spawn run	Ist picking	IInd picking	IIIrd picking
pH	7.10	6.90	6.75	6.35	5.90	5.40
Moisture	6.90	7.20	7.60	8.00	8.10	8.15
Protein	3.50	3.35	5.10	5.30	5.85	5.90
Ash	7.40	6.10	6.50	7.80	8.75	9.30
Crude fibre	40.30	39.00	29.20	28.80	24.50	23.00
Total carbohydrates	80.10	79.00	74.90	68.50	57.80	52.50
Lignin	29.80	28.10	18.50	15.20	13.20	12.50
Cellulose	39.10	38.50	38.00	35.70	30.80	27.50
Hemi -cellulose	21.80	19.10	20.20	16.50	12.30	08.70
Tannin	37.20	36.00	32.60	28.30	25.80	24.30

(The above values are in %)

Table 2 shows the variation in chemical composition of soybean straw during the mushroom growth. In this study it was found that the gradual decrease in pH of substrate from 7.10 to 5.40 % while the increase in moisture content of substrate from 6.90 to 8.15 %. Earlier Funda Atila, (2019) [12] also reported the variation in pH values and moisture content of substrate in the initial period than those of the colonized and spent substrates. Protein content of substrate was 3.50 %, it is decreased up to 3.35 % after sterilization in autoclave. When the spawn of mushroom is allowed to grow on this substrate, the protein content of substrate was found to increase to 5.10 % after colonization of mushroom mycelia over substrate. The protein content of substrate was 5.30, 5.85 and 5.90 % after the successive three pickings. Increase in protein concentration of spent straw was reported earlier by Patil *et al.,* 2010 [35]. This result is also in agreement with the findings of Akinyele and Akinyosoye, 2005. Increased values of crude protein may have been a result of presence of some fungal biomass with substrate (C. Chen *et al.,* 1995.) [6] Ash content of substrate was 7.40 % and decreased after autoclaved to 6.10 %. After spawn run period ash content of substrate was 6.50 % but maximum increase were found (from 7.80 to 9.30 %) during frutification. Zhang *et al*. (2002) [36] and Adamovic *et al*. (1998) also reported an increase in ash content of substrate during fruitfication. M.H.M. Khattab *et al*., 2013 [16] also reported that increase in crude protein (3.4 to 11.7 %) and ash (16.1 to 29.1 %) in rice spent straw. Increased amount of ash in the spent straw may have been due to the decrease in the organic matter content (Escalona *et al*., 2001; Singh,

2000) [10, 32]. Crude fibre content of substrate was 40.30 % which were found to be reduced consistently up to 23.00 % during fungal growth. Decrease in crude fibre content was reported earlier by A.A. Kinfemi 2009 [17], A. Akinfemi *et al*., 2010 [3]. Total carbohydrate content of substrate was 81.10 % which reduced to 74.90 % after spawn run was completed and after IIIrd picking it was 52.50 %. The maximum reduction in cellulose (from 39.10 to 27.50 %), hemicellulose (21.80 to 08.70%), lignin (from 29.80 to 12.50 %) and tannin (from 37.20 to 24.30 %) content of substrate were reported after mushroom growth. It was observed that cellulose degradation rate during fruitification was faster than in spawn run period. Li *et al*. (2001) [19] also noted that the faster rate of reduction of cellulose in substrate after spawn run period. Hemicellulose content of substrate increased slightly during spawn run period then reduced in faster rate. Earlier Pandey and Singh (2014) [25] also reported that during vegetative growth of the fungus, lignin degradation was faster and during fructification, lignin degradation was slowed down than cellulose and hemicellulose. The degradation of lignin was more during spawn run period then the rate of degradation slowed down during fructification. This finding was supported by Singh (2000) [32], Li *et al*. (2001) [19] who reported maximum lignin degradation during spawn run period.

References

1. AOAC. Official methods of the analysis (16th ed.). Arlington, VA: Association of Official Analytical Chemists, 1995.
2. Adamović M, Grubić G, Milenković I, Jovanović R, Protić R, Sretenović L *et al*. The biodegradation of wheat straw by Pleurotus ostreatus mushrooms and its use in cattle feeding. Animal Feed Science Technology,1998:71(3-4):357-362.
3. Akinfemi A, Jonathan SG, Adu OA. Improving the nutritive value of millet stover using biological treatment. Libyan Agriculture Research Centre Journal International,2010:1(3):195-201.
4. Bisaria R, Madan M, Bisaria VS. Biological efficiency and nutritive value of *Pleurotus sajor-caju* cultivated on different agro-wastes. Biol. Wastes,1987:19(4):239-555.
5. Bayer M. The impact of the mushroom Industry on the environment. Mushroom News,1996:44(11):6-13.
6. Chen C, Fales SL, Varga GA, Royce DJ. Biodegradation of Cell Wall Components of Maize Stover Colonized by white-rot fungi and resulting impact on *in vitro* digestibility. J. Sci. Food Agric,1995:68:91-98.
7. Courtney RG, Mullen GJ. Soil quality and barley growth as influenced by the land application of two compost types. Bioresour. Technol,2008:99:2913-2918.
8. Carrasco J, Zied DC, Pardo JE, Preston GM, Giménez AP. Supplementation in mushroom crops and its impact on yield and quality. AMB Expr,2018:8:146-156.
9. Dehariya P, Vyas D. Evaluation of Supplementation of *Daucus carota* on growth parameter and yield of *Pleurotus sajor-caju.* Int. J. of Agriculture and Food Science Tech,2020:11(1):27-34.
10. Escalona CL, Ponce PL, Estrada MA, Solano SG, Ricardo SO, Cutido EM. Cambios en la composición bromatológica del GARAVER inoculado con una cepa de *Pleurotus ostreatus*. Rev. Prod. Anim,2001:13:21-24.
11. Finney KN, Ryu CK, Sharifi VN, Swithenbank J. The reuse of spent mushroom compost and coal tailings for energy recovery: comparison of thermal treatment technologies. Bioresour. Technol,2009:100:310-315.
12. Funda Atila. Compositional changes in lignocellulosic content of some agro-wastes during the production cycle of shiitake mushroom. Scientia Horticulturae,2019:**245:**263-268.
13. García-Delgado C, Jiménez-Ayuso N, Frutos I, Gárate A, Eymar E. Cadmium and lead bioavailability and their effects on polycyclic aromatic hydrocarbons biodegradation by spent mushroom substrate. Environ. Sci. Pollut. Res,2013:20:8690-8699.
14. Jordan SN, Mullen GJ, Murphy MC. Compositional variability of spent mushroom compost in Ireland. Bioresour. Technol,2008:99:411-418.
15. Kaddous FGA, Morgans AS. Spent mushroom compost and deep litre fowl manure as a soil ameliorant for vegetables. In Proc. of Surface Soil Management Rotorua, New Zealand, 1986, 138-147.
16. Khattab HM, Gado HM, Salem AZM, Camacho LM, El-Sayed MM, Kholif AM *et al*. Chemical Composition and *In Vitro* Digestibility of *Pleurotus ostreatus* Spent Rice Straw. Animal Nutrition and Feed Technology,2013:13:507-516.
17. Kinfemi AA, Mohamed MI, Ayoade JA. Biodegradation of Cowpea Shells by *Pleurotus* Species for it Use as Ruminant Feed, World Journal of Agricultural Sciences,2009:5(5):639-645.
18. Lau KL, Tsang TT, Chiu SW. Use of spent mushroom compost to bioremediate PAH-contaminated samples. Chemosphere,2003:52:1539-1546.
19. Li XJ, Pang YZ, Zhang RH. Compositional changes of cottonseed hull substrate during *P. ostreatus* growth and the effects on the feeding value of the spent substrate. Bioresour. Technol,2001:80:157-161.
20. Li XZ, Wu YC, Lin XG, Zhang J, Zeng J. Dissipation of polycyclic aromatic hydrocarbons (PAHs) in soil microcosms amended with mushroom cultivation substrate. Soil Biol. Biochem,2012:47:191-197.
21. Mane VP, Patil SS, Syed AA, Baig MMV. Bioconversion of low quality lignocellulosic agricultural waste into edible protein by *Pleurotus sajor-caju* (Fr.) Singer. Journal of Zhejiang University,2007:8:745-751.
22. Medina E, Paredes C, Pérez-Murcia MD, Bustamante MA, Moral R. Spent mushroom substrates as component of growing media for germination and growth of horticultural plants. Bioresour. Technol,2009:100:4227-4232.
23. Oei P, Hui Z, Jianhua L, Jianqing D, Meiyuan C, Yi C. The alternative uses of spent mushroom compost. In: Proceedings of the 6th international conference on mushroom biology and mushroom products, Bonn, Germany, 2007, 231-245.
24. Patil SS, Ahmed SA, Telang SM, Baig MMV. The nutritional value of *Pleurotus ostreatus* (Jacq.:Fr) Kumm cultivated lignocellulosic agro wastes. Innovative Romanian food biotechnology,2010:7:66-76.

25. Pandey V K, Singh MP. Biodegradation of wheat straw by *Pleurotus ostreatus*. *Cell Mol Biol (*Noisy-le-grand),2014:60(5):29-34.
26. Patil SS. Yield performance and nutritional quality of *Pleurotus florida.* Bioinfolet,2017:14(4A)**:**360-362.
27. Paredes C, Medina E, Bustamante MA, Moral R. Effects of spent mushroom substrates and inorganic fertilizer on the characteristics of a calcareous clayey-loam soil and lettuce production. Soil Use Manag,2016:32:487-494.
28. Paula FS, Tatti E, Abram F, Wilson J, O'Flaherty V. Stabilisation of spent mushroom substrate for application as a plant growth-promoting organic amendment. J. Environ. Manag,2017:196:476-486.
29. Patil SS. Protein content of *Pleurotus* Mushroom grown on different agro-wastes. JETIR,2019:6(6):908-911.
30. Patil SS, Baig MMV. Productivity and nutritional value of *Pleurotus eous.* Bioinfolet,2020:17(2):343-345.
31. Ribas LCC, de Mendonça MM, Camelini CM, Soares CHL. Use of spent mushroom substrates from Agaricus subrufescens (syn. A. blazei, A. brasiliensis) and Lentinula edodes productions in the enrichment of a soil-based potting media for lettuce (lactuca sativa) cultivation: growth promotion and soil bioremediation. Bioresour. Technol,2009:100:4750-4757.
32. Singh MP. Biodegradation of lignocellulosic wastes through cultivation of *Pleurotus sajor-caju*. In: Proceedings of the 15th International congress on the Science and Cultivation of Edible Fungi. Netherlands, 2000, 517-520.
33. Syed Abrar A, Kadam JA, Mane VP, Patil SS, Baig MMV. Biological Efficiency and Nutritional Contents of *Pleurotus florida* (Mont.) Singer Cultivated On Different Agro-wastes. Nature and Science,2009:7(1):44-48.
34. Terashima N, Akiyama T, Ralph S, Evtuguin D, Neto C P, Parkas J *et al*. “2D-NMR (HSQC) difference spectra between specifically 13C-enriched and unenriched protolignin of Ginkgo biloba obtained in the solution state of whole cell wall material”. Holzforschung,2009:63(4):379-384.
DOI: 10.1515/HF.2009.074
35. Telang SM, Patil SS, Baig MMV. Biological efficiency and nutritional value of *Pleurotus sapidus* cultivated on different substrates. Food Science Research Journal,2010:1(2):127-129.
36. Zhang R, Li X, Fadel JG. Oyster mushroom cultivation with rice and wheat straw. Bioresource Technology,2002:82(3):277-284.
37. Zhu B, Fan TX, Zhang D. “Adsorption of copper ions from aqueous solution by citric acid modified soybean straw,” J. Hazard. Mater,2008:153(1-2):300-308. DOI: 10.1016/j.jhazmat.2007.08.050
38. Zhu HJ, Liu JH, Sun LF, Hu ZF, Qiao JJ. Combined alkali and acid pretreatment of spent mushroom substrate for reducing sugar and biofertilizer production*.* Bio resource Technology,2013:136:257-266.
39. Sethuraman G, Nizar NM, Muhamad FN, Tengku TA, Suhairi M, Jahanshiri E, Gregory PJ, Azam-Ali S. Nutritional composition of canistel (Pouteria campechiana (kunth) Baehni). Int. J. Food Sci. Nutr. 2020;5(6):53-7.