Nutritional Content of Soybean Spent Straw.

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Abstract:

Pleurotus florida was cultivated on soybean straw for analyzing the nutritional content of spent mushroom straw (SMS). Results showed an increase in protein (4.30 to 8.80 %), ash (7.50 to 9.70 %) and moisture (7.10 to 8.30 %) content while a decrease in pH (7.25 to 5.40 %), Crude fiber (42.50 to 21.00%), total carbohydrates (80.66 to 48.60%), lignin (29.50 to 12.90 %), cellulose (35.80 to 18.50 %), hemicellulose (20.80 to 12.90 %) and tannin (42.10 to 20.20 %) content in spent straw as compare to soybean straw. During vegetative growth of the fungus (spawn run period), lignin degradation was faster and during fructification, lignin degradation was slower while cellulose and hemicellulose degradation in straw was faster in rate during fruitification. The cultivation of *Pleurotus florida* on soybean straw increased the nutritional content of spent straw. The protein content of spent straw increased while the lingo cellulosic content was reduced, making it more digestible and thus improved the potential feeding value of the resultant substrates as feed resources for ruminants.

Keywords: soybean straw, soybean spent straw, agro waste, *Pleurotus florida*.

Introduction:

In agriculture, there is a production of vast amount of residues every year. These residues need to utilize and dispose in proper manner unless cause a serious environmental pollution and harmful effect on human and animal health. Most of the agro-industrial wastes disposed of either by burning, dumping or unplanned landfilling which create different problems with environment. Many types of agro wastes are potent source of energy for ruminant nutrition but the availability of this energy is very low. To improve the nutritional composition of straw, various chemical and physical methods have been extensively studied, but most of them have not been applicable (Leng, 1991; Sharma et al., 1993; Zahedifar, 1997). Since last decades, biological de-lignification of these agrowaste carried out by solid-state fermentation (SSF) for to remove lignin preferentially (Moyson and Verachtert, 1991; Fazaeli et al., 1999). The agrowaste consist of three major components such as cellulose (40%–50%), hemicelluloses (25%–30%), and lignin (15%–20%) (Chaurasia, 2019). The bio-conversion of agrowaste using white-rot fungi, can improve the digestibility (Zadrazil, 1997; Fazaeli et al., 2003). The components like cellulose, hemicellulose and lignin acts as an energy source for fungal growth as they contain carbon, hydrogen and oxygen, clarifying their degradation during cultivation cycle (Andrade et al. 2010). Among the edible white-rot fungi, the oyster mushroom i.e. *Pleurotus* species have been shown to be more efficient lignin-degrading fungi (Zadrazil et al., 1996; Adebayo et al., 2012a). *Pleurotus* mushroom can degrates the cell wall components present in the raw material, like cellulose, lignin, and hemicellulose through the action of complex oxidative and hydrolytic enzymatic systems (Fernández-Fueyo et al. 2016). Fazaeli, (2007) reported that fungal treatments upgrade the nutritional content of wheat straw by increasing the crude protein and ash content but decreasing the OM, NDF, ADF, ADL, cellulose, and hemicellulose contents. Due to a large variety of non-specific lignocellulosic enzymes produced by *Pleurotus* species, they can be grown on a large number of agro wastes, besides the traditional rice and wheat straw (Zhang, Li, & Fadel, 2002). These straw are generally low in protein content.

In mushroom producing regions, the spent mushroom substrate (SMS), is generated in large quantity as 1 kg of fresh mushrooms utilizes nearly 5 kg of spent substrate (Finney et al. 2009). The traditional methods of disposal or burning it without any important use are neither eco-friendly nor economic (Oei et al. 2007; Carrasco et al. 2018) which could cause a series environmental problems including air pollution. 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 a soil-less growing medium (Medina et al., 2009; Ribas et al., 2009), soil and water bioremediation (García-Delgado et al., 2013; Jordan et al., 2008; Li et al., 2012), energy feed stocks (Finney et al., 2009), animal feeds (Li et al., 2001), and organic amendments (Paula et al., 2017). However, most of these applications are not viable, and are unable to completely solve the disposal problem of SMSs;

only agricultural use is an economically and ecologically acceptable way (Paredes et al., 2016). 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 important information about the nutritional content of the soybean spent straw during and after cultivation of *P. florida* at different growth stages.

Material and Methods:

Strains of Mushroom:

Pleurotus florida strain was obtained from National Centre for Industrial Microbes, National Chemical Laboratory, Pune, India. The 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 121^0C for 30 min. After sterilization, the bags were inoculated with actively growing mycelium of the *Pleurotus florida* 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).

Chemical Analysis:

Analysis of pH, moisture, protein, crude fibre, total carbohydrates, ash, lignin, cellulose, hemicellulose and tannin of samples were done by standard methods (AOAC, 1995).

Result and Discussion:

In order to know the potential of soybean straw, ones used for mushroom cultivation, the chemical analysis of this residue was carried out.

Table 1: Nutritional content (%) of soybean straw at various growth stages of *P. florida.*

Substrates	Un-autoclaved	Autoclaved	Spawn run	Ist picking	IInd picking	IIIrd picking
pH	7.25	6.95	6.42	6.15	5.70	5.40
Moisture	7.10	7.70	7.80	8.00	8.30	8.30
Protein	4.30	4.00	06.20	7.80	8.55	8.80
Crude fibre	42.50	40.00	28.00	27.50	26.00	21.00
Ash	7.50	6.50	7.45	8.50	9.40	9.70
Total carbohydrates	80.66	79.26	75.00	63.50	52.80	48.60
Cellulose	35.80	34.60	31.10	27.60	20.90	18.50
Hemi cellulose	20.80	20.00	19.20	17.80	15.40	12.90
Lignin	29.50	28.20	18.60	16.33	14.20	12.90
Tannin	42.10	39	38	33	24	20.20

Table 1 shows the variation in chemical composition of soybean straw during the mushroom growth. In this study we found that the gradual decrease in pH of substrate from 7.25 to 5.40 % while the increase in moisture content of substrate from 7.10 to 8.30 %. Earlier Funda Atila, (2019) 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 4.30 %, it is decreased up to 4.00 % 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 6.20 % after colonization of mushroom mycelia over substrate. The protein content of substrate was 7.80, 8.55 and 8.80 % after the successive three pickings. Increase in protein content of spent straw was reported earlier by Patil et al., 2010. Crude protein increase could also be due to release of certain proteineous extra cellular enzymes into the substrates during their breakdown and its subsequent metabolism (Kadiri. M, 1999). Ash content of substrate was 7.50 % and decreased after autoclaved to 6.50 %. After spawn run period ash content was raised to 7.45 % but maximum increase were found (from 8.50 to 9.70 %) during frutification. Zhang et al. (2002) also reported an increase in ash content of substrate during fruitfication. Khattab *et al*., 2013 also reported that increase in crude protein (3.4 to 11.7 %) and ash (16.1 to 29.1 %) in rice spent straw. Crude fibre content of substrate was 42.50 % which were found to be reduced consistently up to 21.00 % during fungal growth. Decrease in crude fibre content was reported earlier by Akinfemi et al., 2010. Total carbohydrate content of substrate was 80.66 % which reduced to 75.00 % after spawn run was completed and after IIIrd picking it was 48.60 %. Patil and Baig (2021) also reported decreased in total carbohydrate content of substrate.The maximum reduction in cellulose (from 35.80 to 18.50 %), hemicellulose (20.80 to 12.90 %), lignin (from 29.50 to 12.90 %) and tannin (from 42.10 to 20.20 %) content of substrate were reported. It was observed that cellulose degradation rate during fruitification was faster than in spawn run period. Li et al. (2001) also reported the faster rate of reduction of cellulose in substrate after spawn run period. Earlier Pandey and Singh (2014) also reported that during vegetative growth of the fungus, lignin degradation was faster and during fructification, lignin degradation was slower. Result also showed cellulose and hemicellulose degradation in straw was faster in rate during fruitification.

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), Patil and Baig (2021) who reported maximum lignin degradation during spawn run period.

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