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IMPACT OF AIR POLLUTION CAUSED BY FIRE SMOKE ON YIELD AND NUTRITIONAL VALUE OF *PLEUROTUS (FLABELLATUS) DJAMOR*, R-22

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Abstract

Mushrooms are very sensitive to environmental pollution but no scientific study has been conducted so far to evaluate the effect of air pollution on their growth. The objective of this study was to check the impact of fire smoke caused by burning of solid waste (house-hold and hospital waste) on cultivation and nutrition of mushrooms. Total yield, moisture content, dry matter, ash, proteins, fats, carbohydrates, crude fiber of *Pleurotus (Flabellatus) Djamor* (R-22) commonly known as Oyster mushroom were estimated. The Oyster mushroom was exposed for 20, 40, 60 Min/day to smoke caused by burning of two types of house hold waste and hospital waste in different treatment rooms. Smoke damaged mushrooms soft tissue thus total yield, was reduced to almost half, moisture content and carbohydrates were also significantly reduced. The smoke from hospital waste burning had more harmful effects as compare to smoke from house hold waste burning. However ash, dry matter, protein, and crude fiber were not affected by smoke air pollution.

Keywords: Oyster Mushrooms, waste Burning, Nutrition,

Introduction

The solid waste is usually burnt by the local farmers close to their agricultural fields. This is hazardous for all kinds of plants, their morphology and physiology. The solid waste from house hold and hospital waste is not treated and is disposed off in the open areas. Therefore it is a problem of immediate concern that should be properly addressed. In several municipal regions the house and hospital solid waste carried out by open-burning by means of barrels or other parallel devices (Leghari *et al*., 2015). The burning of different solid wastes (House-hold or hospital waste) adds different kinds of air pollutants in the atmosphere that not only affect human health but also had a bad effect on all kinds of plants and animals. Air pollution effects on vegetables cannot be underestimated as these foodstuffs are important components of human diet. Air pollutants released by the burning of house-hold waste is responsible for the great loss of productivity and plant injuries (Joshi & Swami, 2007; Leghari *et al*., 2015). Jaleel *et al*., (2009) described that any change in the surroundings might be the reason of change in the physiological and biochemical characteristics of vegetation. Leghari and Zaidi (2013) observed the effect of contamination on plant morphology. Khan *et al.,* (2016) reported that temperature and humidity plays a key role in the fungal growth and spore production.

Pleurotus (flabellatus) djamor (R-22) Oyster mushrooms are considered as high nutrition diet. These are the most popular edible mushrooms and belong to the genus Pleurotus and family Pleurotaceae. These mushrooms are rich sources of proteins, vitamins, minerals and fibers. Sharma & Madan (1993) noticed that Oyster mushroom had high protein content such as 30-40% on dry weight basis. These mushrooms have beneficial anti-oxidative effect and included remedial properties. Due to outstanding taste and benefits the usage of Oyster mushrooms in many continental dishes is being increasing day by day. Its cultivation has become a successful lucrative business world wide. The current production of *Pleurotus* species is more than 1.5 million tons in the world and Pakistani export of mushrooms to the Europe is only approximately 90 tons per year (Shah *et al*., 2004). The farming of Oyster mushrooms in both tropical and temperate climate, in short span of time makes it cultivable throughout the year (Amin *et al*., 2007).

Mushrooms are very sensitive to environmental pollution but no scientific study has been conducted so far to evaluate the effect of air pollution on their growth. The objective of this study was to check the impact of fire smoke caused by burning of solid waste (house-hold and hospital waste) on cultivation and nutrition of mushrooms.

Material and Methods

Substrate preparation: For proper cultivation of Oyster mushroom bag and cotton wastes were used, which generally serve as a good source for mushroom substrate. For the cotton waste substrate preparation, the method described by Khan *et al*., (2012) was used. The substrate cotton waste was soaked carefully and layered on a smooth ground separately. Prior to the integration lime in substrate with the help of pH electrode the pH was determined that was 6.55. Then lime was added at the rate of 1%. After mixing lime again pH was measured, that was 7.5. Rice fiber and urea were added as an addition. Cotton waste mixture was fermented for 15 days. The wetness was observed via passing a handful mixture. If there was refusal to overflow of water and the object stay on in that firm, it pointed out that the humidity contents were approximately 65-67 %. Polyethylene baggage of 3 x 6" was filled with equipped substrate by the rate of 400 gm with thirty-one replications. Their mouths were plugged by rubber band tightly. Each treatment was done with three replications that are given below.

T1 Control treatment;
T2 House-hold waste burning treatment (20, 40, 60 Min/day)
T3 Hospital waste burning treatment (20, 40, 60 Min/day)

Spawn run of the bags: Only one foreign strain of Oyster mushroom i.e. *Pleurotus (flabellatus) djamor* (R-22) was grown for farming. Spawn was grown on

sorghum grain and 5gm spawn/bag was utilized for all the treatments and replicates. Immunized packets were plugged again. These packages were placed on racks made by iron in an incubation room at temperature 25°C-30°C with relative humidity 65-70 %. Than spawn baggages were transferred to different growing rooms separately. Further investigation like nutritional analysis, biological efficiency and total yield was determined after 100 % growth was obtained.

Air pollution Treatment: Smoke produced by burning of House-hold and hospital waste for the periods of 20, 40 and 60 Min/day in the growth room for 06 weeks was given to individual growth room as under:

Growth Room 1: Control room (not treated with solid wastes burning)
Growth Room 2: Treated for 20 Min/day with house-holds waste burning smoke
Growth Room 3: Treated for 40 Min/day with house-holds waste burning smoke
Growth Room 4: Treated for 60 Min/day with house-hold waste burning smoke
Growth Room 5: Treated for 20 Min/day with hospital waste burning smoke
Growth Room 6: Treated for 20 Min/day with hospital waste burning smoke
Growth Room 7: Treated for 20 Min/day with hospital waste burning smoke

Examination of nutritional values of Oyster mushrooms: The nutritional value in *Pleurotus (flabellatus) djamor* (R-22) was determined as the methods described in Anonymous (1984). The contents of ash, dry matter, moisture, fiber, proteins, carbohydrates and fats were estimated in 100g of sample. The contents were determined by using the following formula

Total yield determination: The total weight of all fruiting bodies collected from the three pickings of each treatment and control was measured as total yield of mushroom.

$$\textbf{Moisture content}\ (\%) = \frac{\text{Sample fresh weight} - \text{Sample dry weight}}{\text{Sample fresh weight}} \text{ X } 100$$

$$\textbf{Dry matter}\ (\%) = \frac{\text{Dry weight}}{\text{Fresh weight}} \text{X } 100$$

The ash content was determined after incinerating the dry samples at 600 ºC.

Crude Fibers Determination: The sample without fat was in use for the determination of crude fibers contents. 2gm sample was digested in 200 ml sulphuric acid solution for 30 minutes at 80°C. For maintaining the quantity hot water was added regularly. Boiling was stopped by adding 500 ml cold water. The content was filtered under vacuumed condition. Residues were cleaned with hot water for 3 times and then assimilated. The sample was filtered; the crucible was placed in muffle furnace at 65°C for ignition. The percentage of crude fiber was calculated by the given formula:

$$\text{Crude fiber } (\%) = A - (B/W) \text{ X } 100$$

Where, A is the Dry weight after digestion; B is the Weight of ash; W is the Weight of sample.

Total protein content was estimated by using macro Kjeldhal method multiplying by the factor N × 4.38.

Total Crude fats were extracted in ether; it was than dried in oven the percentage was calculated as under;

Crude fat% = (Ether extract weight/ Weight of sample) X 100

Total available Carbohydrates were analyzed by the Clegg's (1956) method.

Statistical analysis: Experiment was repeated 3 times and the results are expressed in mean± S.D. of separate experiments. A two way analysis of variance was used to compare the difference among means at level of significance ($P \leq 0.05$).

Results:

This is the first study to asses the effect of fire smoke waste burning air pollution on Dry matter, Moisture contents, Ash, Protein, Fat, carbohydrates, Crude fiber and total yield of *Pleurotus (flabellatus) djamor* (R-22). *P. djamor* grown in control room and in 6 treatment rooms, where fire smoke caused by the burning of house hold & hospital waste was given for 6 weeks, the results are presented in Table 1. The highest yield of *P. djamor* (5.5kg/m^2) was recorded in control room where no smoke treatment was given. The yield was drastically reduced in treatment rooms where fire smoke from burning house hold waste was given for 20, 40, 60 Min/Day for 6 weeks. The yield decreased to 4.7, 3.6, 2.5 kg/m^2 respectively. The treatment room Nos. 5, 6, 7 where fire smoke from hospital waste burning was given significant reduction in yield was recorded 3.8, 2.9, 2.2 kg/m^2 respectively. The decrease in yield was statistically significant and was correlated with increase in treatment time, minimum yield was recorded when mushrooms were exposed to air pollution for 60min/day (Table 1). Maximum Moisture contents in mushrooms cultivated in controlled environment was 83.64%. It was gradually decreased during different periods (20, 40, 60 Min/day) in house hold waste burning treatment the moisture content was reduced to 75.11, 69.84, 58.01% respectively; whereas in hospital waste burning treatment it was further reduced to 71.00, 64.19, 61.93% respectively. The Dry matter concentration of *P. djamor* in control samples was 16.36%, where as for house hold waste burning smoke treatment (20, 40, 60 Min/day) was 24.89, 30.16 and 41.99% respectively. While in hospital waste burning treatment it was 29.00, 28.81, and 38.07%. Overall minimum Dry matter was in control samples its concentration increased with increased in treatment time, it was high in house hold waste smoke and maximum dry content were found in samples of hospital waste smoke treatments (Table 1).

Ash contents in investigated mushroom were found 12.41% on control treatment, almost similar amount of ash was reported from all other samples treated by the smoke from house hold and hospital waste burning.

Smoke from House hold burning and from hospital waste burning at 20, 40 & 60 Min/day had ash content 12.49, 11.92 and 11.82% and 11.80, 11.1, 12.5% respectively. Total Protein content in Oyster mushroom tested was very high almost similar amount of protein was recorded from control (28.35%) and all the samples treated with smoke from house hold waste and hospital waste burning this ranged from 27.26 to 29.72%. Fat content in Oyster mushroom in control and in all treatments ranged between 3.00 to 3.77%, which showed non-significant variation (Table 1). Maximum carbohydrates were recorded in control samples of Oyster mushrooms (29.16%). The amount of Carbohydrates in the mushrooms grown with smoke treatment of house hold burning waste was gradually decreased with increase in treatment time from (20, 40, 60 Min/day) 27.26, 27.00, 26.00% respectively. While it was further reduced to 27.77, 27.43, 25.85% with increase in treatment time of smoke of hospital waste burning. Crude fiber in Oyster mushroom in treatments with smoke from house hold waste burning was ranged between 29.87 to 28.89%, while smoke burning treatment with hospital waste ranged between 28.79 to 29.31%. Minimum crude fiber was found (27.31%) in control (Table 1).

Table 1. Total yield, Ash, Moisture contents, Dry matter, Crude fibre, Protein, Fat, Carbohydrates of *Pleurotus (Flabellatus) djanor* (R-22) cultivated in controlled conditions and smoke caused by burning different solid house hold & hospital waste.

Nutrients 100 gm	Control	House hold waste burning			Hospital waste burning		
		Duration of Treatment			Duration of Treatment		
(%)		20Min/day	40Min/day	60M/day	20Min/day	40Min/day	60M/day
Treatment room	1	2	3	4	5	6	7
Total yield Kg/m^2	5.5 ±2	4.7±2	3.6±3	2.5±2	3.8±3	2.9±2	2.2±1
Moisture Contents	83.64±3	75.11±2	69.84±2	58.01±3	71.00±2	64.19±1	61.93±2
Dry matter	16.36±3	24.89 ±3	30.16±2	41.99±3	29.00±2	25.81±3	38.07±2
Ash	12.41±2	12.49±1	11.92±1	11.82±1	10.80±1	11.1±1	12.5±2
Proteins	28.35±2	27.26±2	29.36±3	28.98±1	28.99±3	28.93±2	29.72±2
Carbohydrates	29.16±2	27.26±2	27.00±3	26.00±1	27.77±2	27.43±1	25.85±2
Fats	3.77±2	3.70±3	3.09±2	3.60±3	3.65±2	3.23±1	3.00±3
Crude fiber	27.31±2	28.89±3	29.60±2	29.87±2	28.79±23	29.31±3	28.93±3

Results are expressed as mean ± SD; N=3 (P≤0.05), Min = minutes

Discussions

Mushrooms are highly sensitive in nature; fire smoke produced a damaging effect on their morphology and physiology. Long term burning of house hold waste has increase the heat, smoke and other pollutants in the room these remained suspended in the air. It has stopped their proper growth effected their shape and reduced the size. The smoke was also deposited on the upper surfaces hence changing their color and taste. Whereas the effect of hospital wastes burning was found to be more injurious for mushroom's health due to hazardous toxic chemicals. In the present study the decrease in yield is due to long term (6 weeks) treatment that increased the in heat, smoke and other air pollutants inside the treatment room. Similar decrease in yield is reported by a number of researchers (Atkins, 1974; Flegg, 1968, 1970 & 1972). They observed the harmful effects of temperatures above 18^{o}C on cropping mushroom and found reduction in quantity and quality of mushroom. Additionally the growth of competitive or disease causing organisms is enhanced. Several researchers also reported that plants which were sensitive to air pollutants had shown changes in their morphology, anatomy, physiology and biochemistry (Reig-Armiñana *et al*., 2004; Silva *et al*., 2005; Zaidi *et al*., 2005; Leghari & Zaidi, 2013). Hoa & Wang (2015) reported the key reasons that influence mycelium growth for processing of spawn production comprises temperature, culture media, nitrogen and carbon sources, lignocellulosic substrate and grain sources. A significant reduction in Moisture contents was noted in house hold & hospital solid waste burning treatment when compared with control. This moisture content was gradually dropped with increase in air pollution treatment time which is most probably related to increase in room temperature and reduction in humidity level due to waste burning Anderson and Anderson (1981) also found similar climatic effects on moisture content. Overall minimum Dry matter was in control samples its concentration increased with increased in treatment time, it was high in house hold waste smoke and maximum dry content were found in samples of hospital waste smoke treatments. Less dry matter was also reported from Oyster mushrooms grown in normal conditions (Ahmed *et al*., 2013). In general, mushrooms contain 90% of water and 10% of dry mater. The significant increase in Dry matter contents is due to decrease in moisture content of Oyster mushroom. The ash contents in investigated mushroom on control treatment were almost similar amount of ash reported from all other samples treated by the smoke from house hold and hospital waste burning. Similar amount of ash from Oyster mushroom has been reported by Alam *et al*. (2007).

No significant difference in amount of protein produced by the Oyster mushrooms was recorded in this investigation; this proved that the protein content of Oyster mushrooms is not affected by air pollution caused by fire smoke. This is an important finding as mushrooms provide high nutritional value to human beings; these good quality proteins are low cost and easy to harvest. Rich source of proteins that is cheap and easy to harvest. Similar amount of protein contents (21.89%) in Oyster mushroom cultivated on cotton waste was also recorded by Khan *et al*., (2012). The amount of fats in mushrooms was low and the difference between samples was non-significant. This shows that fats are not much affected by smoke of waste burning treatments. Similar level of fat was reported by

Chang & Mshigeni (2001) they found that mushrooms are low in total fat content. Significant difference in carbohydrates between control and waste burning treatments was recorded in this study. The reduction in carbohydrates is due to smoke air pollution that hinders in formation of carbohydrates. The carbohydrates recorded are less than that reported by Dundar *et al*., (2009) they found maximum amount of carbohydrates (77.33% dry weight) and low in crude protein contents (9.12%) in cultivated mushrooms. Crude fiber in Oyster mushroom in treatments with smoke from house hold waste burning was ranged between 29.87 to 28.89%, while smoke burning treatment with hospital waste ranged between 28.79 to 29.31%. Minimum crude fiber was found in control (27.31%). In this investigation the difference in crude fiber content between control and treatment samples was non significant this proves that crude fiber content is also not effected by smoke waste burning treatments. Almost similar crude fiber content was reported by Peter (1991) he found that mushroom is a food of high quality flavor and nutrition value has high content of protein, low content of fat and high content of fibers.

Conclusion

The vital conclusion of this investigation was sum upped as:

The Pleurotus (flabellatus) djamor (R-22) was cultivated on different air pollutant treatments for the estimation of air pollution effects on total yield and nutrients (Protein, Fat, Crud fiber, Ash, Dry matter, Moisture Contents and Carbohydrates). The efficiency of diverse nutrients including Moisture Contents, carbohydrates and Total yield in Oyster mushroom were found significant less as compared to control treatment. It was also concluded that hospital wastes burning is more dangers than the house hold waste for mushroom nutrients, further that The amount of Total yield, Carbohydrates and Moisture Contents in the mushrooms was gradually decreased with increase in treatment time (20, 40, 60 Min/day).

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