Agrosearch (2012) 12 No.2: 206 - 215 Http://dx.doi.org/10.4314/agrosh.v12i2.8

Effects of Compost on Mycelia Growth and Fructification, Mineral Elements and Proximate Composition of *Pleurotus pulmonarius* (Fries)

*Ugioro, O.[1,] , Kadiri, M.[2] and Fademu, Y.O.[3]
[1]Cocoa Research Institute of Nigeria, (CRIN), Ibadan
[2, 3]Department of Biological Sciences, University of Agriculture, Abeokuta, Ogun State.
**Corresponding Author*: ugioro2002@yahoo.com

ABSTRACT

Studies were conducted on the growth and cultivation of Pleurotus pulmonarius (Fries) singer on lingo-cellulosic waste. Long composted substrate formulations of sawdust (86%) + rice bran (10%) + cassava peel (4%) supported the longest mycelia growth and density. Long composted also produced larger fruitbodies and significant increase in number of fruitbodies and compost % yield compared with uncomposted substrate having the same formulations. The mineral elements of Mg, Cu, Fe, Mn, Na, K, and P were found to increase from very young to mature fruitbody of both composted and uncomposted substrate with preponderance of potassium. Similar results were obtained for crude protein. However, organic carbon and organic matter tend to decrease from very young to mature fruitbody of composted and uncomposted substrates.

Keywords: Composting, Fructification, Mineral Elements *Pleurotus pulmonarius, Organic carbon and Organic matter.*

Introduction

Mushrooms are saprophyte growing on dead organic matter of vegetative origin', they grow well on a wide range of lignocellulosic wastes substrates (Okhuoya and Okogbo, 1990; Kadiri, 1991). It has been established that they grow and fruit on various agricultural wastes (Moncaio et al., 2005). Furthermore, some of these mushrooms have been cultivated in the laboratory (Kadiri, 1994; Fasidi, 1995).

Several species of mushrooms are edible. Some are medicinal like *Auriculaiara* sp. and *Tremella fusiformis* for treating haemorrhoids and maintaining healthy lung tissue, respectively while other like *Pholiota squarrasa* and *Amanita vaginata are poisonous* (Chang and Mile, 2004)

In mushroom cultivation, supplementation of the lignocellulosic organic waste has been found to increase yield. Zadrazil (1980) obtained yield increase of *Pleurotus* by adding lignocellulosic wastes.

Some organic additives are cotton seed, rice and wheat bran, plant hormones, maize chaff and animal dungs (Han et al., 1981; Quimino, 1981; Bahl, 1988; El-Katta et al., 1991). Waste materials such as sawdust, rice straw, sugar cane debris and non-controlled environmental condition have been utilized for *pleurotus ostreatus* cultivation (Macaya- Lizano, 1988).

Worldwide production of cultivated edible mushroom currently amounts to approximately 3700,000 tons (Maynard, 1994). About 38% of this accounted for by *Agaricus bisporus*, followed by the oyster mushroom, *pleurotus ostreatus* (24.2%) (Schmidt,1993). Because of increasing mushroom cultivation, these fungi now have a more important role in human nutrition. Mushrooms are highly nutritious containing 19 -35% protein, low fat content 1.3 2.9%), relatively large amount of carbohydrate and fibre ranging from 57 88% and 4 to 20% (dry matter). In addition, they are rich in minerals cobalt (Hayes, 1972).

Kadiri and Fasidi (1990) also observe that *P .pulmonarius* fruitbody is nutritional and very rich in protein. In Nigeria, *P. pulmonarius* is consumed not only for its flavor and nutritive value, but also for beneficial medicinal effect (Zoberi, 1973).

Compost fermentation also known as composting is a process of microbial decomposition and fermented agricultural wastes are believed to be richer in nutrients than unfermented waste (Stametes, 1993; Quimio et al., 1990).

The present study was carried out to assess short and long composting on fruitbody production, proximate composition and mineral contents of very young, young and mature stages of *P. pulmonarius* fruitbodies on different substrates.

Materials and Methods

A. Preparation of Composted and Uncomposted Substrates(PCUS)

For both composted and uncomposted substrates, the following substrate formulations were tried.

Sawdust (86%) + rice bran (10%) + cassava peel (4%) with the addition of calcium sulphate in order to lower the substrate pH. The above three formulations were prepared on cemented floor, the substrate raw materials mixed thoroughly and water content increased by adding water until a moisture level of about 70% was achieved. In the case of the substrate formulation employed as composted (fermented) substrate the heaps (each 1m x

1m x 1m) of the moisture substrates raw materials were turned as follows:

Day 0 - Stack the head

Day 2 - First turning

Day 3 - Second turning

Day 4 - Third turning

Substrate formulations to be utilized as uncomposted substrates were not to be turned but utilized on the day of preparation, immediately after watery. Turnings is a process of disassembling and reassembling of compost which allows compost aeration, full mixing of the compost and thereby prevent uneven decomposition . The composted and uncomposted substrates were packed separately into 80 replicates of heat resistance polypropylene bags (40 per substrate type) at 2kg per bag. The bags were tied at their opening with rubber bands and sterilized in an autoclave at 1.25kg/cm (151blin^2) for 30min.

B. Inoculation of Composted and Uncomposted Substrate Materials and Incubation

On cooling at room temperature, the autoclave polypropylene bags containing composted and uncomposted substrate materials were opened and inoculated singly with planting spawn of *P. pulmonarius* at 5% level under a sterile condition. Method of obtaining planting spawn from grain matter spawn is fully described by Kadiri and Kehinde (1999). The inoculated composted and composted substrate in polypropylene bags were incubated at 29 ± 2^{O}C, relative humidity of 60 ±70% until the substrates were fully ramified with vegetative mycelia of *P. Pulmonarius.*

This took six weeks. At the sixth week of incubation, the polypropylene bags containing inoculated and incubated composted and uncomposted substrates were transferred into a fruiting chamber at temperature 27 ± 2^{O}C, relative humility 80 ± 5%.

At one and half week later, when primordial formation (initial fruiting stage) was observed, the bags were open in order to allow aeration and watery was done once a day for 7 days. For both composted and uncomposted substrates, the number and yield of healthy mature fruit bodies were noted.

C. Effects of long composting (26 days) on yield of *P. pulmonarius.* The experimental set up was the same as in A above, except that only the yield of the mushroom was determined.

Sawdust, rice bran and cassava peel were used as substrates raw materials opened and turned according to the following time schedule:

Day 0 - Stack the head
Day 5 - First turning
Day 10 - Second turning
Day 14 - Third turning
Day 18 - Fourth turning
Day 22 - Fifth turning
Day 26 - Sixth turning

At each turning, water was sprinkled on the compost to make up for the lost of water due to evaporation. The prepared compost was packed, sterilized and inoculated with planting spawn of *P. pulmonarius* as in A above and thereafter observed for fructification. The time of primordial formation, number and yield of healthy fruit bodies (fruitbody 1kg compost), biological efficiency and number of flushes produced were noted. The fructification environment was maintained at $27 \pm 2^{O}C$ and high relative humidity of $80 \pm 5\%$.

Organic carbon, organic matter, crude protein and crude fibre of each sample were determined by drying in an oven at $80^{O}C$ for 2 days according to the standard and method (Association of Official Agricultural Chemist (AOAC, 1990).

D. Minerals

Magnesium, Copper Iron, Manganese, Zinc, Sodium, Potassium and Phosphorus were determined at the University of Agriculture, Abeokuta, Nigeria, by automated atomic absorption spectrophotometry and flame photometry.

Results and Discussion

Significant increase were obtained for both long (26) composted and short (7) composted substrates as well as uncomposted control as the number of days after inoculation increases (Table 1). The highest mycelia extension was observed for long composted substrate (26 days) when grown on sawdust (86%), rice bran (10%) and cassava peel (4%) was significantly higher at 5% level of probability when compared to uncomposed control (Table 1). Quimio (1981) obtained similar result for *Auricularia SP* cultured on

sawdust with 5% super supplement produced the best growth. Han et al. (1981) also obtained a similar result on mycelia density using *Lentinus edodes* colonized sawdust with wheat bran and soya bean, sesame and peanut cake and obtained increased mycelia growth optimally at 5% level of probability.

Long composted substrate (26 days) had the highest mean number of healthy fruitbodies which was significantly higher than those of the short composted and uncomposted (control) substrates (Table 2). Similar result was obtained (In Table 2) for mean fresh weight (g) in two flushes. Long composted substrate consistently produced the highest percentage yield when compared to control. However, no significant difference was noticed between them. Kadiri, (1990) obtained biological efficiency of 4% in two flushes for *Lentinus subnudus* cultivated on uncomposted rice straw substrate. The reason for this result could be that during the period of long composting, accessible nutrients are easily degraded by microorganisms which make the substrate more selective for the desired mushroom.

Table 1: Mycelial Extension (cm) and Density of *Pleurotus pulmonarius* Inoculated on Long, Short and Ucomposted Agricultural Waste at Different Number of Days After Inoculation.

Substrate types	Mean mycelia extension (cm)	Mean mycelia density
Long composted substrate	14.53a	+15
Short composted substrate	9.00b	+16
Uncomposted substrate (control	8.00b	+16

Means followed by the letter(s) are not significantly different at 5% level of probability using Duncan multiple range

Table 2: Percentage Yield of *P.pulmonarius* Produced by Long, Short and Uncomposted Substrate (g) in Two Flushes

Substrate types	Mean weight of fresh weight(g) of fresh produced	Biological efficiency Spawned substrate (g) (% yield)	Mean number of health fruitbodies produced	y Mean fruitbodies
Long composted substrate	1283.13[a]	47.75[a]		
	47.82[a]		3.73[a]	
Short composted substrate	1293.48[a]	26.50[b]		
	44.62[a]		3.45[a]	
Uncomposted substrate (control)	1315.80[a]	30.75[b]		
	35.99[b]		2.74[a]	

Means followed by the letter(s) are not significantly different at 5% level of probability using Duncan Multiple Range

Table 3: Mineral Composition (mg/100g dry matter) of *P. pulmonarius* at Very Young, Young and Mature Fruit Body Stages Produced on Composted Substrates.

Mushroom Stages	Mg	Cu	Fe	Mn	Zn	Na	K	P
Very young	2.24	0.041	0.036	0.12	0.19	5.60	29.00	0.75
Young	3.24	0.044	0.038	0.15	0.37	6.35	31.00	0.58
Mature	4.30	0.055	0.098	0.17	0.48	9.10		

Table 4: Mineral Composition (mg/100g dry matter) of *P. pulmonarius* at Very Young, Young and Mature Fruit Body Stages Produced on Composted Substrates.

Mushroom Stages	Mg	Cu	Fe	Mn	Zn	Na	K	P
Very young	2.57	0.036	0.82	0.12	0.13	5.15	15.50	1.46
Young	2.94	0.038	0.90	0.15	0.17	6.20	30.50	1.57
Mature	2.95	0.098	0.90	0.15	0.23	7.90		

Table 5: Proximate Composition of *P. pulmonarius* at Very Young, Young and Mature Fruit Body Stages Produced on Composted Substrates.

Mushroom Stages	Organic Carbon	Organic Matter	Crude Protein	Crude Fibre
Very Young	47.48	82.09	40.73	5.71
Young	42.69	73.8	46. 76	4.12
Mature	37.11	64.16	55.60	3.11

Table 6: Proximate Composition of *P. pulmonarius* at Very Young, Young and Mature Fruit Body Stages Produced on Composted Substrates.

Mushroom Stages	Organic Carbon	Organic Matter	Crude Protein	Crude Fiber
Very Young	37.52	65.55	29.33	5.09
Young	33.52	57.96	31.52	3.3
Mature	4.19	7.24	38.39	4.31

The quantities of mineral elements in *P. pulmonarius* showed a common trend of increase from very young to mature fruitbody, with the preponderance of potassium in both composted and uncomposted substrate (Table 3). Similar distribution of mineral elements was observed in *V. volvacea* and *P. tuber regium*

(Kuforiji, 2005) as well as similar result in previous studies (Fasidi and Kadiri, 1990; Kadiri and Fasidi, 1990a). The preponderance of potassium may be due to the more absorption and accumulation of this element from the substrate.

The implication of this finding of increased mineral elements with maturity is that, the most mature fruit body of *P. pulmonarius* is the most nutritious and is therefore recommended for human consumption. The organic matter showed a common trend of decreasing quantities from very young to mature fruit body stage of both composted and uncomposted substrate (Table 5 and 6). There was an increase in crude protein from very young to mature stages in both composted and uncomposted substrate. However, the reverse was the case for crude fibre (Table 5 and 6). This shows that *Pleurotus pulmonarius* can be eaten at mature stage as an alternative to fish and meat in rural and urban areas where these items are expensive. Decrease in organic carbon and organic matter from very young stage to mature fruitbody showed that the very young fruitbody is a developmental stage which mark the onset of fruit formation and as a result the very young fruit body tends to have higher value in organic matter and organic carbon. This result agrees with earlier works done on sporophore of *P.tuber regium* (Kadiri and Fasidi, 1990), *L. Subnudus* and *T. robustus* (Fasidi and Kadiri i, 1990). With reference to protein, curde fibre, organic carbon and organic matter, the *P. pulmonarius* cultivation on composted substrate of fruit bodies was the richest.

Conclusion

From the foregoing, it is clear that the *Pleurotus pulmonarius* can be cultivated on Local Agricultural Wastes in Nigeria(LAW). Instead of incinerating some of these wastes as is practiced elsewhere, they can be converted into high value protein and minerals necessary for human consumption.

References

AOAC (1990), Official Methods of Analysis, 15th ed., *Association of Official Analytical Chemists*, Arlington, VA

Bahl, (1988). Handbook on mushroom 2nd edition, *Oxford and IBH Publishing Co. PVT Ltd.* New Delhi, Bomhay Calcutta :8 -62.

Chang, S.T. and Mile, P.G. (2004). Mushroom cultivation, *nutritional values and medicinal effects and environmental impact 2nd edition.* New York: CRC Press.

El-kattan, M.H., Helmy, Z.A., Mahmound, B.H. and Kawi K.A.A. (1991) . Effect of additives on oyster mushroom production. *Mushroom J. Tropics* 11:67-74.

Fasidi IO (1995). Studies on *Volvariella esculenta* (Mass) Singer. Cultivation on agricultural wastes and proximate composition of stored mushrooms. *J. Food Chem.*, 55(2): 161-163.

Fasidi, I.O. and Kadiri M. (1990). Changes in nutrient contents of *Termitomyces robustus* (Beeli) Hein and *Lentinus subnudus* Berk during sporophore development. *Acta Botanica Hungarica* 36: 167-172.

Han, Y.H., Ueng, W.T., Chem, L. C. and Cheng, S. (1981). Physiology and ecology of *Lentinus edodes*. *Mushroom Sci.* 11: 623-658

Hayes, V.A. (1972). Nutritional factors in relations to mushroom production. *Mushroom Sci.* 8: 558-663

Kadiri, M. (1990). Cultivation of *Lentinus squarrosulus* on uncomposted substrate in Nigeria. *Global J. and Applied Sciencens* 5: 41-44

Kadiri M (1994). Effect of additives on mycelial growth and fructification of *Pleurotus squarrosulus* (Polyporales: Polyporaceae). *Rev. Biol. Trop.*, 42(1-2): 49-52.

Kadiri, M. and Fasidi, I.O. (1990). Variation in chemical composition of *Chlorophyllum molybditus* (Mayevex, for Manses and *Pleurotus tuber-reguim* (fries) during fruitbody development. *Nigeria J. Science*24:86-88

Kadiri, M. and Kehinde, I.A. (1999). Production of grain mother and planting spawn of *Lentinus Subnudus* Berk, *Nigeria J. Bot* 12:37-44.

Kuforiji, O.O. (2005). Utilization of agro-wastes for the cultivation of *P. tuber-reguim* (fr) Macaya-Lizano, A.V. (1988). Cultivo de *Pleurotus ostreatus* species afines sobies medios naturals semi-esteriles. *Rev. Biol. Trop.* 36:255-260.

Mile, G.P. and Chang, S.T. (1997). Mushroom biology; concise basics and current development London. *World Scientific Publishing Co. Ltd.*

Maynard, A.A. (1994) Sustained vegetables production for three years using composted animal manures. *Compost science and utilization 2 :* 88-96.

Macaya-Lizano, A.V. (1988). Cactivo-de *pleurotus ostreatus* species afines sobies medios naturals semi-estriles. *Rev. Biol. Trop.* 36: 255-260

Okhuoya JA, Okogbo FO (1990). Induction of edible sclerotia of *Pleurotus tuber-regium* (Fr) Sing. *In the laboratory. Ann. Appl. Biol.,* 117: 295-298.

Quimio, J.H., Chang, S. T. and Royse, D. J. (1990). Technical guidelines for mushroom growing in the tropics *FAO Rome :* 65 -80.

Quimio, T. H. (1981). Philippine *Auricalarias:* Taxomony, nutrition and cultivation. *Mushroom Sci.* 11: 685 - 696.

Stamets, P. (1993). Growing gourment and medicinal mushroom. *OlympiaWashington: fungi perfecti*.

Zadrazil, F. (1980). Influences of ammonium nitrate and supplement on the yield of *Pleurotus sajor caju* (Fr.) sing. *Enr.J.Appl. Mircobial Biotechnol* 9:31-35.

Zoberi, M.H. (1973). Some edible mushroom form Nigeria. *Nigerian field*, 38:81-90.