Advances in Science and Technology, Vol. 2, No.2, July/August 2008, pp84-8.

Growth, Media Degration and Sclerotia Proximate of *Pleurotus tuberregium* (fries) Singer on Agro Residues

O. O. Idowu and M. Kadiri*
Department of Biological Sciences, University of Agriculture, Abeokuta, Nigeria
(Submitted: September 20, 2007; Accepted: May 2, 2008)

Abstract

A study was conducted to investigate the growth, media degration and sclerotia proximate composition of *Pleurotus tuberregium*, an edible mushroom from Nigeria on agricultural wastes, and the wastes employed in this study were sawdust, maize cob, coconut fibre and a mixed bed. Assessments were based on substrate weight at harvesting. Biological efficiency, mycelia extension and density weight of substrate at spawning, harvest and after harvest and proximate composition of the sclerotia were also investigation. Results showed that sawdust gave the highest sclerotial yield of 59.9g with the least weight of 30g recorded on grass straw. The spent substrate weight at harvest was highest on grass straws (302.6g) and lowest in sawdust (231.93g). The highest degraded substrate was sawdust and the least was grass straw. It was also observed that all wastes employed in this study supported the growth of mushroom mycelium with the highest growth occurring on grass straw, coconut fibre, maize cob, mixed bed and sawdust with the lowest occurring on cocoa shell and soya husk. Protein was the most abundant nutrient in the sclerotia of the mushroom with the value ranging from 13.08-17.25%. The ethanol soluble sugar and lipid contents were generally low in the sclerotia grown on all test substrates. With regard to protein and lipid, the sclerotia grown on grass straw contained the highest dry matter, crude fibre and ash, and those harvested on grass straw and mixed bed contained the highest moisture with the least moisture in sawdust. The results are discussed in relation to the prospects of cultivating this edible mushroom in Nigeria as a nutritious food and for waste recycling.

Keywords: Pleurotus tuberregium, Growth, media degradation, agro residues proximate

1.0 Introduction

Mushrooms are important as food and medicine (Oso, 1977, Bonatti *et al*., 2004; Cheung & Cheung, 2005). Edible mushrooms are highly nutritive with exotic culinary value, which made them to be an acceptable delicacy worldwide. They are rich in protein, vitamins and mineral elements. Mushrooms appear in traditional Yoruba artwork as the "tie and dye" (Adenle, 1990) and also feature in Nigeria folklore and mythology (Oso, 1977).
Cultivation of edible mushrooms with agricultural residues, such as maize cob, sawdust and grass straws, is a value added process to convert these materials, which are otherwise considered to be wastes into human food. It represents one of the most efficient biological ways by which these residues can be recycled (Madan *et al*., 1987).

Pleurotus tuberregium is an economically important edible mushroom popularly eaten in Nigeria (Oso, 1977). Zoberi (1973) observed that this fungus is common in Nigeria and often found growing around the African bread fruit (*Treculia Africana*). It is a woodrotten fungus that forms sclerotia with irregular globose to ovoid shape measuring up to 30cm in diameter within the remains of rotten wood log. Both the fruit body and the sclerotium are eaten in Nigeria (Oso, 1977; Alofe *et al*., 1998). The sclerotium is highly nutritive, rich in proteins and considered as a delicacy. The fruit body of this mushroom was found to have a high quality plant protein which has an excellent amino acid profile which is a rich addition to human diets (Akindahunsi and Oyetayo, 2005). Though widely obtained and consumed, the cultivation of *Pleurotus tuberregium* has been considered primitive in Nigeria. The tubers are obtained from their natural habitat, planted and watered to induce fruiting which occurs at a relatively short period of 14-21 days (Patrabash and Madan,

* Corresponding author e-mail: ibibaforuambo@yahoo.co.uk

1997). This ensures a ready and regular supply of fresh mushroom since rapid deforestation is destroying their natural habitat.

Most plant litters and agricultural residues are made up mainly of lignin, hemicellulose, cellulose and other polysaccharides. These substances are so complex that most micro organisms are not able to efficiently break them down and unlock the nutrients that are in their complex structures. The ability of the mycelium to efficiently break down lignocellulose is thought to be associated with the mycelium growth habit which allows the fungus to transport scarce nutrients like nitrogen and iron into the substrate on which it is growing. They produce enzymes like lignin and manganese peroxidases which break down the complex bonds and make nutrients available to plants and other micro organisms. Spent mushroom compost can be used as soil conditioner and animal feed. In the process, environmental pollution may be reduced as disposal of these wastes may become less of a problem.

Based on 10% conversion efficiency and 90% moisture content in the fresh mushroom (Madam *et al*., 1987; Stamets, 2000), one dry metric tonne of rice straw would yield about 1,000kg of the oyster mushroom worth about 8,800 US dollars at the current retail price of 8.8 dollars per kg. Therefore mushroom cultivation may become one of the profitable agricultural businesses that could produce food products from sawdusts, grass straws and maize cob, as well as help dispose of them in an environmentally friendly manner.

The primary objectives of this study were to determine the bio degradation efficiency of the agricultural residues employed in the study and to compare mushroom yields in terms of biological efficiency.

2.0 Materials and Methods

2.1 Source of Selerotia

Selerotia of *Pleurotus tuberregium* was obtained from villages around Imo State. These were cropped to obtain fresh fruit bodies of the mushroom. Mycelium was established on potato dextrose agar by tissue culture of young fruit bodies harvested from the sclerotium. The pure culture was maintained on potato dextrose agar (PDA) for regular sub culturing throughout the period of investigation.

2.2 Mycelial growth on agro residues

Soyabean (*Glycine max)* husk, coconut (*Cocos nucifera*) fibre sawdust, maize cob, grass straws (*Panicum maximum*), cocoa (*Theobroma cacaco*) shell and a mixed bed in which the above items were manually chopped into 1 – 3cm except sawdust which already had small particle size served as media for growing these sclerotia. These wastes were separately soaked overnight and drained the following morning to rid them of excess water until the moisture content was about 65%. These were filled into test-tubes (2.5 x 20cm), plugged with cotton wool covered with aluminium foil and autoclaved at 121^{o}C for 15 minutes. Each treatment was replicated 4 times. After cooling, each waste was inoculated with fresh mycelium of *P. tuberregium* (5mm diameter) and incubated at room temperature for 10 days. At the end of the incubation period, mycelial extension was measured and mycelial density was visually compared on the various wastes.

2.3 Cultivation on agro residues:

Sawdust, maize cob, cocoa shell, coconut fibre, soya bean husk, grass straws and a mixture of all the substrates were separately soaked overnight as described above. Polyethylene bags were filled with 500g of each waste and autoclaved at 121^{o}C for 30 minutes. On cooling, each substrate was thoroughly mixed with 50g of spawn. Spawn was produced using a mixture of sorghum and rice bran (9:1), moistened as described above, mixed thoroughly and autoclaved. After cooling, these were inoculated with fresh mycelium block of *Pleurotus tuberregium* and incubated for 10 days at room temperature. These spawns were used to inoculate the agricultural residues with each treatment replicated 4 times, and incubated for three and half months after spawning. Sclerotia were then harvested and weighed. The biological efficiency of each substrate was calculated according to the method of Khanna and Garcha (1982).

2.4 Proximate analysis

Moisture content of each sample was determined by direct oven drying method. The loss in weight after oven drying 1g each of the sample at 105^{o}C to constant weight was expressed as percentage moisture content (AOAC, 1990). Crude fiber was determined according to the standard method of Association of Official Analytical Chemist (AOAC, 1950).

Ethanol soluble sugar was extracted for 6 hours in a soxhlet extractor in boiling 80% ethanol and quantified by the phenol sulfuric acid method of Duboid *et al*. (1956). Crude fat was determined by using soxhlet extraction method, using petroleum ether as the solvent (AOAC, 1984). Ash was determined as the residue of a gram powdered sample in a crucible of known weight at 550^{o}C in a muffle furnace (AOAC, 1984).

The micro-kjeldahl method was used for the determination of nitrogen. The protein content was determined by using the adjusted conversion factor (4.38) because of the presence of non-protein nitrogen in mushroom protein (Oei, 1991; Shashirekha *et al*., 2002; Akindahunsi and Oyetayo, 2005).

The data obtained were analyzed by using SAS and means separation was done using Duncan multiple range test.

and sawdust respectively. Soya husk and cocoa shell were the least. However, there was no significant difference in mycelia growth between grass straw and coconut fibre (Table 1). In terms of mycelial density, coconut fibre had the highest, followed in order by grass straw, maize cobs and the mixture, with the least mycelia density in soya husk (Table 2).

In similar studies, Quimio (1981), Fasidi and Ekwere (1993), Kadiri and Arzai (2005) found that *Volveriella volvaceae*, *Pleurotus sajor-caju* and *Lentinus subnudus* can be cultured on a wide variety of agricultural wastes. The growth of *Pleurotus tuberregium* on the test agricultural residues implies that the mushroom is able to secrete oxidizing and hydrolyzing enzymes which degrade the substrates and the mycelia in turn absorb them for their growth. This present finding suggests that coconut fibre, a waste from *Cocos nucifera* which is a common waste in the rainforest zone can be used as basal substrate for mycelium production. The poor growth of *Pleurotus tuberregium* on soya husk and cocoa shell, as found in this study, may be due to high protein content in these wastes which encouraged the growth of other competitive fungi over and above that of mycelium of our choice. This is consistent with the finding of Stamet (2000) who suggested that such substrates should only be used as supplements to the basal substrate which is usually less nutritive.Protein was the most abundant nutrientin the sclerotia of the mushroom with value

Table 1: Proximate composition of sclerotia of *Pleurotus tuberregium* in agro residues

Treatment	Moisture contents (%)	Dry matter	Protein (%)	Crude fat (%)	Ash (%)	Crude Fibre (%)	Ethanol (%) Soluble sugar
Sawdust	36.89^{c}	63.11^{a}	13.08^{c}	0.30^{b}	10.37^{a}	9.28^{a}	0.31^{a}
Maize cob	45.68^{b}	54.32^{b}	14.92^{b}	0.02^{d}	7.21^{b}	9.02^{a}	0.25^{ab}
Grass straw	51.35^{a}	48.65^{c}	17.25^{a}	0.69^{a}	6.25^{bc}	8.64^{a}	0.17^{b}
Mixed bed	50.59^{a}	49.41^{c}	15.14^{b}	0.24^{c}	4.03^{c}	7.03^{b}	0.19^{c}

3.0 Results and Discussion

All the substrates employed supported mycelial growth. The best substrate was grass straw from *P. maximum*, followed by coconut fibre, maize cob

ranging from 13.08-17.25%. The ethanol soluble sugar and lipid contents are generally low in the sclerotia grown on all the test substrates. With regard to protein and lipid, the sclerotia grown on grass straw contain the highest.

Table 2: Mycelial extension of *Pleurotus tuberregium* on wastes

Treatment	Mycelia Extension	Mycelia Density
Grass straws	10.7[a]	7+
Coconut fibre	9.6[a]	8+
Maize cob	8.8[a]	7+
Mixture	8.3[a]	7+
Cocoa Shell	4.8[bc]	2+
Soya husk	3.6[c]	1+

A mycelia density was estimated on a visual scale of 1+ - 8+ with 1+ being the least dense.

a daily basis in timber shades of most cities contributing to environmental pollutants. Instead of burning these wastes, they can be used in the cultivation of edible mushrooms including sclerotia. The spent substrate can also be used as soil conditioner or animal feed.

Acknowledgement

The financial assistance of International Foundation for Science (IFS) to M. Kadiri is gratefully acknowledged.

Table 3: Sclerotia yield of *Pleurotus tuberregium* on agro wastes

Treatment	Initial substrate dry wt (g)	Substrate weight at spawning	Substrate weight at harvest (g)	Total Sclerotia yield (g)	Sclerotia substrate wt (g)	Mean degraded substrate %	Biological Efficiency %
Sawdust	175	500	231.93[c]	59.93[a]	172.00[d]	53.61[a]	34.25[a]
Maize cob	175	500	276.60[bc]	52.50[b]	224.16[c]	44.68[b]	30.00[b]
Grass straw	175	500	302.60[a]	29.98[c]	272.35[a]	37.48[bc]	17.13[d]
Mixture	175	500	288.70[b]	45.3[bc]	243.35[b]	42.26[b]	25.9[c]

Means followed by the same superscript letter(s) in each column are not significantly different (P>0.01) by Duncan's multiple range test.

In the cultivation of the sclerotia, sawdust, maize cob, grass straw and the mixture of the three substrates supported the cultivation of the mushroom, with sawdust producing the highest sclerotia yield (59.93g) while grass straw produced the lowest (29.98g) (Table 3). These yields are comparable with those for other mushrooms by Yildiz *et al*. (1998), Zhang *et al*. (2002), Idowu (2002) and Kadiri (2005). However there is a significant difference in the yield of sclerotia produced on sawdust and maize cob which implies that sawdust is the best substrate for sclerotia production in *Pleurotus suberregium*. This mushroom in its natural habitat (decaying log and buried roots of deciduous trees) degrade woods hence its ability to reduce the sawdust by more than 50% (Table 3).

Sawdust is the most popular substrate used on commercial farms in most south – east Asian countries (Quimio *et al*., 1990). It is also a common waste in Nigeria where tones of it are produced on

References

Adenle, V. A. 1990, "The potentials of mushrooms as a food resource for rural dwellers", Professors world peace. Academy Publication, New York, pp 80-95.

Akindahunsi, A. A. and Oyetayo, F. L. 2005, "Nutrient and anti-nutrient distribution of edible mushroom, *Pleurotus tuberregium* (fries) singer", Science Direct, L., W. T., www.Elsevier (on line in press).

Alofe, F. V., Odu, E. A. and Illoh, H. C. 1998, "Mushroom, man and nature. Edible wild mushroom, on decaying wood in Obafemi Awolowo University Campus", *Nigerian Field*, **68**, 14-21.

AOAC 1990, "Official methods of analysis (15th edition) Washington D.C., Association of Analytical Chemists.

AOAC 1984, Official methods of analysis (14th edition) Washington D.C., Association of Analytical Chemists.

AOAC 1950, Official methods of analysis, Washington D.C., pp 152-155.

Bonaitti, M., Karnopp, P., Soares, M. H. and Furlan, S. A. 2004, Evaluation of *Pleurotus ostreatus* and *Pleurotus sajor – caju* nutritional characteristics when cultivated in different lignocellulosis wastes. *Food Chemistry* **88**, 425-428.

Cheung, L. M. and Cheung, P. C. K. 2005, "Mushroom extracts with anti oxidant activities against lipid peroxidation", *Food Chemistry* **89**, 403-409.

Dubois, M., Gilles, A. K., Hamilton, J. K., Rebers, A. P. and Smith, F. 1956, "Colorimetric method for determination of sugars and related substances", *Analytical Chemistry*, **28**(2), 350-355.

Fasidi, I. O. and Ekuere, U. U. 1993, "Studies on *Pleurotus tuberregium* (fries) singer: cultivation, proximate composition and mineral contents of sclerotia", *Food Chemistry*, **48,** 225-259.

Idowu, O. O. 2002, "Evaluation of different substrates and combination in the cultivation of *Pleurotus pulmonarius"*, Proc. of the Annual Conference of Hortson, 14th – 17th May, 2002 pp. 121-124.

Kadiri, M. and Arzai, A. H. 2005, "Cultivation of *Lentinus subnudus* on woodlogs", *Bioresource Technology*, **95**, 65-67.

Kadiri, M. 2005, "Nutritional requirements of *Lentinus subnudus*, a Nigerian edible mushroom", *XVI International Botanical Congress Abst.* No. 4604, Poster No. 2377.

Khanna, S. A. and Garcha, H. S. 1984, "*Pleurotus* mushroom a source of food protein", Mushroom News Letter for the Tropics **4**(3), 9-14.

Madan, M., Vasudevan, P. and Sharma, S. 1987, "Cultivation of *Pleurotus sajor caju* on different wastes", *Biol. Wastes*, **22**, 241-250.

Oei, P. 2003, Benefits of mushroom. In mushroom cultivation, appropriate technology for mushroom growers, Backhys Publisher, Leiden, The Netherlands, 202-250.

Oei, P. 1991, "Manual of mushroom cultivation techniques, species and opportunities for commercial cultivation in developing countries", CTA, pp 21-26.

Oso, B. A. 1977, "*Pleurotus tuberregium* from Nigeria", *Mycologia*, LXIX C(2): 271-279.

Patrabash, S. and Madan, M. 1997, "Studies on cultivation, biological efficiency and chemical analysis of *Pleurotus sajor – caju* (FR) singer: on different wastes", *Biotechnology*, **17**(2), 107-122.

Quimio, T. H., Chang, S. T. and Royse, D. J. 1990, "Technical guidelines for mushroom growing in the tropics", *FAO Plant Production and Protection Paper* 106, pp 160-170.

Stamets, P. 2000, Materials for formulating fruiting substrates. In Growing Gourmet and Medicinal Mushrooms, 3rd edition. Ten Speed Press, Berkeley, Toronto, pp 140-180.

Yildiz, A., Karakaplan, M. and Aydin, F. 1998, "Studies on *Pleurotus ostreatus* (Jacq. Exfri) kum. var. salignus (Pers. Ex Fr.) Konr. Et Maubl: cultivation, proximate composition, organic and mineral composition of carpophores", *Food Chemistry* **61**(1), 127-130.

Zhang, R., Zinjin, Li and Fadel, J. G. 2002, "Oyster mushroom cultivation with rice and wheat straw", Bio-Resource Technology, **82**, 277-284.

Zoberi, M. H. 1973, "Some edible mushrooms from Nigeria", *Nigerian Field* **38**, 81-90.