African Journal of Biotechnology Vol. 8 (2), pp. 215-218, 19 January, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

Evaluation of yield of oyster mushroom (*Pleurotus pulmonarius*) grown on cotton waste and cassava peel

Grillo Joseph Adebayo[1]*, Banjo Nusirat Omolara[2] and Abikoye Elizabeth Toyin[2]

[1]Department of Microbiology, Lagos State University, Ojo, P. M. B 1087, Apapa, Nigeria.
[2]Federal Institute of Industrial Research, Oshodi, P. M. B 21023, Ikeja, Nigeria.

Accepted 17 September, 2008

This work evaluated the yield of *Pleurotus pulmonarius* on different mixtures of cotton waste and cassava peel. *P. pulmonarius* demonstrated significantly higher colonization rate on cotton waste substrate (100 g cotton waste) 3 weeks after inoculation of spawn than any other substrate mixtures. Cotton waste had the shortest time for full mycelial ramification (3 weeks) and mushroom primodial appearance ($3^1/_2$ weeks). At 7^{th} week of cultivation, substrate mixtures; 20 g cotton waste + 80 g cassava peel and the cassava peel substrate (100 g) had not ramified, therefore, no appearance of mushroom pinhead. The highest yield was observed on 100 g cotton waste with mushroom yield of 79.4 g followed by 80 g cotton waste + 20 g cassava peel with 72.0 g. Cassava peel (100 g) produced no mushroom fruit. The least mushroom yield of 3.0 g was obtained from the substrate mixture 20 g cotton waste + 80 g cassava peel. The highest number of flushes obtained was 4 recorded for substrate mixtures 70 g cotton waste + 30 g cassava peel, 50 g cotton waste + 50 g cassava peel, 40 g cotton waste + 60 g cassava peel and 100 g cotton waste. The results showed that cotton waste was a better substrate for cultivation of *P. pulmonarius* than cassava peel. However, with the high availability of cassava peel in Nigeria, the potential use of this waste as substrate adjunct (at 20% of substrate) can be suggested based on the findings of this study. It can be deduced from this study that cassava peel may be used for mushroom cultivation if supplemented with a good nitrogen source.

Key words: Mushrooms, *Pleurotus pulmonarius*, cotton waste, cassava peel.

INTRODUCTION

Mushrooms, locally known as 'olu' in the Southwestern part of Nigeria are a group of fungi belonging to the class Basidiomycetes and order Agaricales. They are distinguished by their characteristic umbrella-like fruiting bodies, from which they derived the name, mushroom. Mushroom sauce is a local delicacy, popular among the indigenous southern population of Nigeria. Prior to the commercial cultivation of mushrooms in Nigeria, a large proportion of the people had relied on collection of wide mushrooms with the occasional dare consequences of mortality (and less frequently morbidity) as a result of consumption of poisonous species of mushrooms (Uraih and Izuagbe, 1990).

*Corresponding author. E-mail: jaagrillo@yahoo.com. Tel: 08055318821, 07023316275, 08034670963.

Mushroom has a high protein content of 25 – 50% and also composes of fat (2 – 5%), sugars (17 – 47%), mycocellulose (7 – 38%), minerals (8 – 12%) and vitamins such as D, C, B1, B5, B6, niacin and riboflavin (Miles and Chang, 1986; 1997). Apart from serving as a protein food, for which they are most popular in Nigeria, mushrooms are also medicinal and have some biotechnology–based functions (Taniguchi, 2000). One of the values of commercial cultivation of mushrooms, especially in a developing economy like Nigeria, is the availability of large quantities of several agro–industrial wastes which can serve as substrates for the cultivation of mushrooms (Banjo et al., 2004). It has been reported that mushrooms can grow on chopped cocoa pods, cotton waste, dried chopped maize straw, oil palm (fibre and bunch) wastes, tobacco straw, used tea leaves, rice straw, sugarcane bagasse, newsprint, old rags and sawdust (Banjo et al., 2004).

Cassava (*Manihot esculenta* Crantz) is one of the most important food plants in West Africa and many parts of the tropics, where several cassava derived products form the staple food (Rombouts and Nouts, 1990). The cassava peel, traditionally, is used as feed for domestic ruminants with substantial percentage ending up as waste. With the recent government promotion of cassava production and exportation, there is need to explore better possible utilization of the cassava peel waste for economic development. This study was designed to evaluate the yield of *P. pulmonarius* grown on cotton waste supplemented with different proportions of cassava peel.

MATERIALS AND METHODS

Cotton (*Gosspypium hirsutum*) waste was gotten from Atlantic Textile Manufacturing Company, Lagos, Nigeria. Cassava (*M. esculenta* Crantz) peel was collected from a local 'fufu' industry at Iju–Ishaga, Lagos, Nigeria. Calcium carbonate ($CaCO_3$) was bought from a local laboratory reagents retailer at Ojota, Lagos. *Pleurotus pulmonarius* was obtained from the culture collection of edible mushrooms in the Federal Institute of Industrial Research, Oshodi (FIIRO). The *P. pulmonarius* culture was subcultured on Potato Dextrose Agar (PDA) plates and incubated at room temperature (28°C) for 7 days.

Production of mushroom spawn

Spawn of *P. pulmonarius* was produced using the method of Quimio et al. (1990). 1 kg of cotton waste (as substrate) was soaked in 2.06 L of water containing 62.5 g $CaCO_3$. The soaked cotton waste (CW) was gently squeezed to remove excess water and shredded into tiny pieces and 70 g amounts were packed into washed and drained 'jam' bottles. The openings of the bottles were covered with aluminium foil which was firmly held in place by rubber bands. The substrates in the bottles were sterilized in an autoclave at 121°C for 60 min and allowed to cool to room temperature in complete darkness for 2 weeks to allow the mushroom mycelia to permeate the substrate.

Cultivation of mushroom on cotton waste–cassava peel substrate

The cassava peel (CP) was dried so as to remove cyanide because mushrooms pick up the content of their substrates. The dried cassava peel (CP) and cotton waste (CW) were composted differently with $CaCO_3$ and water in the ratio 32:2:66 substrate, $CaCO_3$ and water respectively. Cotton waste was shredded into tiny pieces. The cassava peel was milled and different quantities weighed. Similar quantities of cotton waste were also weighed.

The weighed CW and CP substrates were mixed in different proportions each amounting to 100 g. The mixed substrate was heaped up with the aid of square wooden frame for a period of 14 days to compost. The heap was turned on alternate days to allow proper aeration and even distribution of all the nutritive ingredients. After the composting, the substrate was pasteurized at about 70°C for 2 h and allowed to cool to room temperature before filling in polyethylene (Santana) bags. From a 10 day old well ramified spawn of *P. pulmonarius*, a few grains were inoculated onto the substrate in each bag under aseptic conditions. The openings of the bags were carefully tied with rubber band to avoid contamination. The inoculated bags were covered with black cloth and incubated at room temperature to allow ramification of the mushroom mycelia. The period of full ramification (change of colour from dark brown to white) was noted for each substrate mixture. The bags were torn open after full mycelial ramification and maintained at temperature between 26 – 30°C with adequate aeration, watering and high humidity. The time of pin head (primordia) development was recorded. The harvesting was done in 4 flushes of 1 week intervals. After the 2nd flush, the substrate was turned upside down and regularly watered to harvest the 3rd and 4th flushes.

RESULTS AND DISCUSSION

The results on Table 1 indicate the ability of cotton waste to facilitate faster growth of *P. pulmonarius* than cassava peel, since the substrate mixture 100 g CW had the shortest time for full mycelial ramification (3 weeks) and mushroom primordial appearance ($3^1/_2$ weeks). As at the 5th week of cultivation, substrate mixtures 20 g CW + 80 g CP and 100 g CP had not ramified; consequently there was no primordial appearance. The work of Belewu et al. (2006) showed that *P. sajor-caju* colonization on cotton by-products was more rapid than sawdust and completed within one week. This, however, depends on the size of compost in the polyethylene bags.

The yields of *P. pulmonarius* on different proportions of CW + CP, shown in Table 2, reveal no growth of *P. pulmonarius* on 100% CP substrate. This is probably due to the presence of little or complete lack of some vital nutrients, especially nitrogen, needed for *P. pulmonarius* growth in cassava peel. Nitrogen is an important basic nutrient for microorganisms, being required for protein, nucleic acid and chitin (in the case of fungi) synthesis. Zadrazil and Kurtzman (1982) reported that the yield of pleurotus mushroom can be boosted by the addition of nitrogenous supplements. In particular they have reported urea and soya bean (separately as nitrogen sources) as effective supplements to improve the yield of *Pleurotus* mushrooms.

The production of a high yield (79.4 g) of *P. pulmonarius* on cotton waste substrate (100 g CW) and the observation that the yield of *P. pulmonarius* gradually reduced as the concentration of CW reduced, showed that CW is a better substrate for the cultivation of *P. pulmonarius* than CP. This is probably due to higher nitrogen content in CW than CP and higher proportion of cellulose content and compactness on wetting. Anyakorah and Olatunji (2001) cultivated oyster mushroom on different agro industrial wastes and reported that *P. sajor-caju* grew well on all cellulosic wastes but cotton waste had the highest yield. They also reported higher nitrogen content (5.67%) in CW than in CP (4.44%). The result also conforms to the report of Chang (1984) that cotton waste gave a higher and more table yield of mushrooms than any other agroindustrial wastes which could be due to high proportion of cellulose and compactness on wetting. Silva et al. (2002) also reported higher yield of *P. pulmonarius* on *Gossypium hirsutum* than on *Cymbopogan citratus* and *Panicum maximum* jacq.

Table 1. Time for full mycelial ramification and primordial appearance of *P. pulmonarius*.

Substrate CW (g) + CP (g)	Time of full mycelial ramification (wks)	Time of primordial appearance (wks)
100 + 0	3	$3^1/_2$
80 + 20	4	$4^1/_2$
70 + 30	5	6
60 + 40	6	7
50 + 50	6 (PR)	$7^1/_2$
40 + 60	7 (PR)	8
30 + 70	7 (PR)	8
20 + 80	7 (NR)	9
0 + 100	NA	NA

PR = Partial ramification, NR = no ramification, NA = no appearance, CW = cotton waste, and CP = cassava peel.

Table 2. Yields (g) of *P. pulmonarius* on different proportions of cotton waste – cassava peel substrate.

Substrate CW (g) + CP (g)	Flushes				
	1st	2nd	3rd	4th	Total
100 + 0	42.4	17.0	12.0	8.0	79.4
80 + 20	40.0	22.8	10.0	NG	72.8
70 + 30	30.0	25.2	5.9	1.0	62.1
60 + 40	22.0	20.0	18.0	NG	60.0
50 + 50	20.2	15.0	10.0	5.0	50.2
40 + 60	15.0	10.0	7.0	5.0	37.2
0 + 70	10.0	NG	NG	NG	10.0
20 + 80	3.0	NG	NG	NG	3.0
0 + 100	NG	NG	NG	NG	NG

NG = No growth, CW = cotton waste, and CP = cassava peel.

Conclusion

The highest yield of *P. pulmonarius* (79.4 g) was obtained from the cotton waste substrate (100 g CW). Presently, cotton waste is not so readily available in Nigeria due to increasingly fewer number of textile industries in the country. Cassava peels, on the other hand, is a readily available waste in the country and with the current support given to cassava cultivation, especially cassava processing for export, there is going to be increasing amount of cassava peel as waste. The yield (72.8 g) of *P. pulmonarius* obtained from substrate mixture; 80 g CW + 20 g CP indicates the potential use of cassava peel as substrate adjunct (at 20% of substrate) for the cultivation of oyster mushroom. This way, the cassava peels may be useful in the production of a valued proteinous food.

REFERENCES

Anyakorah CI, Olatunji O (2001). Cultivation of oyster mushroom; *Pleurotus sajor-caju* on different agro-wastes. World J. Biotechnol. 2: 266-270.

Banjo NO, Abikoye ET, Kukoye AO (2004). Comparison of three nutrient supplements used as additive to sawdust during the cultivation of oyster mushroom (*Pleurotus pulmonarius*). Niger. J. Microbiol. 18: 335-336.

Belewu MA, Aderolu ZA, Banjo NO, Musa AK, Oyerinde AA, Abdusalami OS (2006). Potential application of fungal biotechnology on the nutritional evaluation of sawdust-gliricide mixture by rat. Res. J. Biotechnol. 1(2): 36-39.

Chang ST (1984). Conversion of agricultural and industrial wastes into fungal protein. Conserv. Recycling. 7(2-4): 175-180.

Miles PG, Chang ST (1986). Application of biotechnology in strain selection and development of edible mushrooms. Asian Food J. 2(1): 3-10.

Miles PG, Chang ST (1997). Mushroom Biology. World Scientific Press, Hongkong. pp. 1-96.

Quimio TH, Chang ST, Royse DJ (1990). Technical guidelines for mushroom growing in the tropics. FAO Plant Prod. Prot. Paper 106: 23-25.

Rombouts FM, Nouts MJR (1990). Microbial fermentation in the production of plant foods. J. Appl. Bacteriol. 97: 1085-1175.

Silva SO, Games da Costa MS, Clemente E (2002). Chemical composition of *Pleurotus pulmonarius* (Fr.) Quell substrates and residue after cultivation. Braz. Arch. Biol. Technol. pp. 1-8.

Taniguchi M (2000). The Japanese Mushroom Industry. Farming. Jpn. 34: 35-40.

Uraih N, Izuagbe Y (1990). Non-bacterial Food-borne Diseases. In: Public Health Food Ind. Microbiol. pp. 90-91.

Zadrazil F, Kurtzman RH (1982). The Biology of *Pleurotus* cultivation in the Tropics. In: Tropical Mushrooms; Biological Nature and Cultivation Methods. Chang ST, Quimios TH (eds). The Chinese University Press, Hongkong. pp. 277-298.