International Journal of Botany

ISSN: 1811-9700

science alert

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International Journal of Botany 3 (4): 394-397, 2007
ISSN 1811-9700

Cultivation Studies on *Psathyrella atroumbonata* Pegler. A Nigerian Edible Mushroom on Different Agro Industrial Wastes

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Abstract: Studies were carried out on the cultivation of *Psathyrella atroumbonata* Pegler on various agricultural wastes to determine their suitability for mycelial growth and sporophore yield. The maximum mycelia extension growth of the mushroom was recorded on Oil Palm Fruit Fibers (OPFF) and corn cobs. This was followed by rice straw, corn stem, guinea grass, banana leaves and sawdust in that order. The highest sporophore yield (fresh weight) was on sawdust. This was followed by rice straw and banana leaves, while oil palm fruit fibers gave the least sporophore yield of the mushroom. There was no sporophore formation on corn cobs, corn husks and guinea corn shaft despite mycelial growth on them. Sporophore formation was preceded by a gradual increase in temperature which dropped just before the actual sporophore emergence. This study highlights the possibility of using selected agricultural wastes for the cultivation of *Psathyrella atroumbonata.*

Key words: Cultivation, *Psathyrella atroumbonata*, edible mushroom, agro-industrial wastes

INTRODUCTION

Psathyrella atroumbonata Pegler is an economically important edible mushroom, which is popularly consumed in many parts of Nigeria. According to Nicholson (1989) this mushroom is one of the common mushrooms found in Akwa Ibom State of Nigeria. The mushroom is a lignicolous fungus commonly found growing in small clumps on or around dead rotten trees or on dead roots of wood that is at the last phase of decomposition. The mushroom fruitbodies are used either fresh or dried in Nigeria. The mushroom is highly nutritive and very rich in protein, crude fibre, ash and low lipid and sugar content (Ayodele, 2006). It is consumed in Nigeria mostly because of its flavour and nutritive value.

The cultivation technique of this mushroom has not been fully developed. Because of its nutritive value, people hunt for it in the wild during its growing season and make money by selling it. Rapid agricultural and urban developments are destroying the natural habitats of edible mushrooms growing in the wild (Fasidi and Ekwere, 1993; Agina and Joshua, 2004; Ishikuemhen *et al*., 1999). In view of this, commercial cultivation of some of the wild mushrooms will not only ensure that we obtain them regularly but also help in preserving their germplasm. In our preliminary studies, we have established that *P. atroumbonata* mycelium grows on agar media within a temperature range of 20-30°C (optimum 25°C) and pH range of 4-9 (optimum 6-8) Ayodele and Okhuoya (2007). This study reports on cultivation of *Psathyrella atroumbonata* using locally available materials.

MATERIALS AND METHODS

Inoculum preparation: The mushroom was collected in the wild around dead decaying wood of *Gmelina arborea* in Isanlu, Kogi State, Nigeria. Tissue cultures were made from the sporophore to prepare pure culture of the mushroom in the Department of Botany (mushroom unit) University of Benin, Benin City, Nigeria in August, 2004. The pure cultures were maintained on Potato Dextrose Agar (PDA) and kept in refrigerator at 5°C till when needed.

Growth on agro-industrial wastes: The following agricultural wastes were used to cultivate the mushroom: corn cobs, banana leaves, corn stems, corn husks, guinea corn shaft, guinea grass, rice straw, sawdust of Mahogany wood and Oil Palm Fruit Fibres (OPFF). These materials, except sawdust, were chopped into small pieces (1-5 cm), soaked in tap water and heaped for 7 days to ferment and with turning every two days (Quimio *et al*., 1990). The fermented wastes was mixed with 1% Calcium Carbonate ($CaCO_3$) and 1% sugar on oven dry weight basis. The moisture content of the fermented wastes was adjusted to 75% with addition of sterile water. Five hundred grams oven dry weight equivalent of the

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fermented and moistened substrates were loaded into cellophane bags measuring 15×30 cm each. Three replicate bags were prepared for each substrate. A polyvinyl chloride (PVC) pipe (neck) measuring 5 cm wide and 3 cm long was passed through the top of the bag. Thereafter, the mouth of the bag was plugged with cotton wool and covered with foil paper. The bags were then loaded into a steamer and steamed for 4 h at the temperature of about 70°C. They were allowed to cool down to ambient temperature before they were inoculated at 5% level of spawning (w/w). The spawn (mushroom seeds) was prepared using sorghum grains. Inoculated bags were kept on a clean bench in the laboratory at 28±2°C and an average relative humidity of 90%.

After complete colonization of the substrates by the mushroom mycelium, the bags were opened for fruiting. This was followed by periodic watering of bags every other day with 150 mL of sterile water per day to avoid dryness. The following parameters were determined: Average number of days for complete colonization of substrates, mycelial density, time taken to form sporophore, fresh weight of sporophore and biological efficiency. The percentage biological efficiency was calculated by fresh weight of mushroom divided by the dry weight of substrate and multiplied by hundred while mycelial density assessment was done according to Kadiri and Fasidi (1994).

Data analysis: All the results obtained were analyzed using simple descriptive statistics such as mean and standard error. Means were separated using analysis of variance (ANOVA) by using an SPSS Statistical package.

RESULTS

The mushroom mycelia grew satisfactorily on all the substrates tested. The mushroom gave the fastest mycelial extension on OPFF and corn cobs with an average of 12 days for complete colonization of the substrate. This was followed by rice straw and corn stem (13 days), guinea grass (14 days), banana leaves (15 days) and sawdust (16 days). The longest period for complete colonization was observed on corn husks (20 days) (Table 1).

The first sporophore emergence was observed on rice straw after about 96 days of the inoculation of the substrates. This was followed by banana leaves (99 days), guinea grass (102 days), sawdust (102 days), OPFF (106 days) and the longest time before sporophore emergence was observed on corn stem (108 days). There was no sporophore formation on corn cobs, guinea corn shaft and corn husks despite the mycelial growth on them (Table 1).

The highest fresh weight of the mushroom was on sawdust (61.63±0.08) followed by rice straw (59.97±0.09) banana leaves (56.97±1.42) and OPFF which gave a very low productivity of the mushroom (37.27±1.43) (Table 1). There was temperature change in some of the substrate materials during the cultivation of the mushroom. The temperature in all the substrates was fairly stable during the first 3 weeks of inoculation. This was followed by a period of rise in the temperature, which coincided with the period of fermentation and decomposition of the substrates. After the 7th week, the temperature dropped before the emergence of the sporophore. This was observed mostly in sawdust, banana leaves and rice straw. The highest temperature was observed in banana leaves and corn stems while the lowest temperature was in corn husks (Table 2).

Contaminants found during the cultivation of the mushroom on various agricultural wastes are shown in Table 3. These were mostly moulds which are commonly encountered on corn cobs, corn husks, OPFF and corn stems. Their effects ranged from delay to complete inhibition of sporophore formation.

Table 1: Growth of *Psathyrella atroumbonata* on different agricultural wastes

Substrate colonization[a]	Substrates emergence[b]	Sporophore of sporophore	Fresh weight (g)
Corn cobs	12.30±0.33	-	-
Corn stems	13.67±1.20	108.00±1.53	38.63±1.35
Corn husks	20.00±0.58	-	-
Oil palm fruit fibres	12.00±0.58	106.67±0.88	37.27±1.43
Banana leaves	15.00±0.58	99.67±0.88	56.97±1.42
Sawdust	15.33±0.88	102.33±1.20	61.63±0.08
Guinea grass	14.33±0.67	102.33±1.20	53.10±0.75
Rice straw	13.00±0.58	96.67±0.88	59.97±0.09
Guinea corn shaft	16.00±1.66	-	-

[a] = Average No. of days for complete colonization of substrates, [b] = Average No. of days for sporophore emergence

Table 2: Fungal weeds associated with the substrates during the cultivation of *Psathyrella atroumbonata*

Substrate	Fungal species	Effect
Corn cobs	*Neurospora* sp.	Inhibition of sporophore formation.
Corn stems	*Neurospora* sp.	Delay of sporophore formation.
Corn husks	*Neurospora* sp. *Penicillium*	Complete inhibition of sporophore formation.
Oil palm fruit fibres	*Aspergillus*, *Rhizopus*, *Neurospora*	Found on the substrates but no serious effect on the mushroom.
Banana leaves	*Aspergillus*, *Penicillium*	Found on the substrate but no serious effect on the mushroom.
Sawdust	*Rhizopus*, *Penicillium*, *Aspergillus*	Found on substrates but no serious effect on the mushroom.

Table 3: Weekly temperature changes in the substrates during cultivation of *Psathyrella atroumbonata* on different wastes

Substrate	1	2	3	4	5	6	7	8
Sawdust	26.30±0.40	26.80±0.47	25.80±0.72	30.60±0.40	30.90±1.10	31.20±1.06	30.70±0.96	28.30±0.95
Banana leaves	28.40±1.01	30.70±1.06	31.10±0.93	31.60±1.04	28.60±1.65	28.10±1.41	27.50±0.71	27.10±2.03
OPFF	27.60±0.96	27.80±0.51	29.60±0.29	28.10±0.82	28.33±1.40	28.30±0.90	28.10±0.93	26.20±0.90
Rice straw	27.60±0.96	30.10±0.57	32.00±0.67	29.60±0.35	30.00±0.67	28.90±0.75	29.10±0.62	27.60±0.90
Corn husks	25.60±0.71	26.60±1.21	26.30±1.04	30.20±0.84	28.87±0.58	28.40±0.75	26.60±0.66	27.20±1.62
Corn stems	27.90±0.23	31.40±0.70	30.40±0.70	28.70±0.83	30.10±0.50	26.30±1.00	29.73±0.20	28.10±0.82
Corn cobs	26.70±1.02	26.70±1.65	28.30±1.65	30.10±0.51	29.80±0.30	27.40±0.68	28.10±0.68	28.00±0.45

DISCUSSION

The observations that the mushroom grew successfully on these wastes indicate its (mushroom) potential in the bioconversion of these materials. According to Buswell and Chang (1993), the ability of the different mushroom species to utilize various substrates will depend on both the mushroom and the substrate associated factors. Hence, growth and fruiting of an individual mushroom species on a particular substrate will depend largely upon the ability of the mushroom to utilize the major components of that substrate as a nutritional source. It also indicates that the mushroom can produce hydrolyzing and oxidizing enzymes which can hydrolyze the wastes (Okhuoya, 1997; Wuyep *et al*., 2003).

Stamets (2000) states that many wood decomposing mushrooms can be grown on non-wood based substrates such as cereal straws, corn stalks, sugarcane, bagases, coffee pulp, banana leaves, seed hulls and a wide variety of other agricultural waste products. He, however, stated that not all wood-decomposing mushrooms adapt readily to these wood-free substrates. In this study, *P. atroumbonata* adapted readily to the non-wood substrates tested. The observation of this mushroom in the field shows that it has a high saprophytic ability and can grow on a variety of cellulosic wastes.

The observation of the utilization of these agro-industrial wastes by the mushroom is in line with the reports of Okhuoya and Okogbo (1991), Okhuoya and Etugo (1993), Ishikuemhen and Okhuoya (1996), Okhuoya *et al.* (1998), Ayodele *et al.* (2007), Ishikuemhen *et al.* (1999) and Kuforiji *et al.* (2003). They reported that *Pleurotus tuberregium* and *Lentinus* species grew successfully on diverse substrates, which includes corn cobs, rice straw and sawdust of some forest trees. In the same vein, Fasidi and Ekuere (1993) successfully cultivated *Pleurotus tuberregium* on grass straws, corn cobs, rice straw, banana leaves and cassava peels. In this study the best stimulatory wastes were sawdust, rice straw and banana leaves. The least stimulatory substrate in terms of yield was OPFF. This supported Fasidi and Ekuere (1993) who reported a poor stimulatory effect of OPFF on *Pleurotus tuberregium*.

In a similar study, Fasidi and Kadiri (1993) found that *Lentinus subnudus* could be cultivated on a wide variety of agricultural wastes. Quimio (1981) also reported that *Auricularia* sp. has been successfully cultivated on a wide variety of agricultural wastes. In this study, there was mycelial development on corncobs, corn husks and guinea corn shaft but sporophore did not develop on them. This may be due to the fact that the mushroom could not fully hydrolyze the substrates and convert the nutrient content for sporophore formation.

The temperature change observed during the cultivation of this mushroom on different waste materials was in line with the study of Stamets (2000) who found that after colonization of the substrate is complete, heat generation abates and many species of mushrooms will not form sporophores unless the substrate temperature drops. A similar observation was recorded in this study. The mushroom starts to form sporophores when the temperature drops. Contaminations of mushroom substrates are not uncommon. Different contaminants are associated with different stages of mushroom cultivation. The observation in this study is in line with the study of Stamets and Chilton (1983). Most of the contaminants encountered were also reported by Ishikuemhen *et al.* (1999) on *Pleurotus tuberregium* substrates. The sources of contaminants could be through the air, the substrates, spawn materials, equipment used, containers or facilities used during the cultivation processes (Stamets and Chilton, 1983).

This study shows that *P. atroumbonata*, a delicious edible mushroom can be cultivated on various agricultural wastes. These wastes are usually discarded or destroyed by burning. Since this mushroom can utilize these wastes satisfactorily by converting them into high price mushroom produce, the wastes can become a supplementary source of income for the farmers who may sell them to the mushroom growers or use them for mushroom production as a linkage industry. This will also help to reduce the pollution effect of the substrates in the environment.

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