Comparism of growth and yield of *Pleurotus plumonarius* cultivated on corn cob, coconut coir and banana leaf.

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ABSTRACT

This study was carried out to investigate the effect of three different agricultural wastes on the growth and yield of *Pleurotus plumonarius* (Fr.) P. Kumm 80g of each substrate (corn cob, coconut coir and banana leaf) was weighed into uniformed size screwed capped bottles (17cm x 8cm^3), inoculated with 10g of the spawn of *P. plumonarius* each and incubated at 30±2ºC for 6 weeks. The fresh weight, dry weight, biological efficiency, productivity and proximate content of the fruit bodies were determined as index of growth. The result showed that fructification was initiated 4 days after exposure. It was observed that Banana leaf produced fruit bodies with the highest fresh weight (21.30g), dry weight (4.06g), biological efficiency (13.14%) and productivity (2.31%); while Coconut coir had the lowest fresh weight (4.30g), dry weight (0.43g), biological efficiency (2.9%) and productivity (0.50%). The proximate analysis showed that. *P. plumonarius* presents a good content of protein, minerals and low fat content on each substrate. This study revealed that *P. plumonarius* can be easily cultivated on readily available lignocellulose wastes in Nigeria.
Keywords: *Pleurotus plumonarius*, corn cob, coconut coir, banana leaf, proximate content.

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INTRODUCTION

Mushrooms 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 their name. Mushrooms are found in temperate, tropical, shady, woody, open and well-lighted habitats. They are known to grow on varieties of agricultural wastes. Cultivation of mushroom can be viewed as an effective means to extract bio resource left behind in agro-industrial solid residues and simultaneously as a sound environmental protection strategy (Adejoye and Fasidi, 2009). Furthermore, the use of these residues in bio-processes may be one of the solutions to bioconversion of inedible biomass residues into nutritious protein rich food in the form of edible mushroom (Chiu et al., 2000; Jonathan and Adeoyo, 2011).

Mushrooms generally are known for their high protein content, fat, minerals, carbohydrates etc. therefore are essential for human consumption. Edible mushrooms are a good source of food protein. They exhibit wide variations in their protein content. Even varietal and strained differences in protein content have been reported. The protein content of the cultivated species ranges from 25-50% and also composes of fat (2-5%), sugars (17-47%) and mycocellulose (7-38%) (Miles and Chang, 1997). Mushroom contains many essential amino acids. White button mushrooms are example that contain more protein than kidney beans. As a group, mushroom also contain some unsaturated fatty acids, provide several of the B vitamins and Vitamin D. Some even contain significant Vitamin C as well as the minerals, potassium, phosphorus, calcium and magnesium (Park, 2001). The objective of this research is to compare the growth and yield of *P. plumonarius* (an oyster mushroom) on three different substrates: corn cobs, coconut coir and banana leaves.

MATERIALS AND METHODS

The fungus used for this study was *P. pulmonarius,* which was obtained from the laboratory collection of the Federal Institute of Industrial Research (FIIRO), Oshodi, Lagos State, Southwest Nigeria. The culture was maintained on 4% malt extract agar medium at 30+2ºC.

Preparation of Substrates

The three substrates used for this study were corn cob, coconut coir and banana leaf. The corn cob was sun-dried and chopped into pieces, both the coconut coir and banana leaf (hay) were shredded into pieces. 80g dried corn cob was weighed into screwed cap bottles which were uniform in size. Moisture content of the substrate was adjusted to 60% with distilled water. Eighty grams of coconut coir and banana leaves were soaked in hot water for about 30 minutes and were squeezed gently to remove excess water and thereafter were packed into screwed cap bottles. They were sterilized for 15 minutes at 121ºC and 96 psi, allowed to cool down to ambient temperature and spawned with 10g of the pure culture of the mushroom *P. plumonarius.* The uniform size screw capped bottles were subsequently placed into a spawn running room at 30± 2ºC under dark conditions. After six weeks of spawn running, the uniform size screw capped bottles were placed into a growth chamber and exposed for fructification at 15± 2ºC and 80-90%RH. Evaluation of the mycelia growth was carried out according to the method of Ahmed *et al* (2009). Biological efficiency and the productivity of the substrates were calculated according to the method of Marcelo *et al*,(2001).

$$\text{Biological efficiency (B.E)} = \frac{\text{Mushroom fresh weight}}{\text{Compost initial dry weight}} \times 100$$

$$\text{Productivity (P)} = \frac{\text{Mushroom dry weight}}{\text{Compost initial dry weight}} \times 100$$

Chemical biomass composition

Proximate composition of fruit-bodies was determined according to A.O.A.C (1998), and ash content obtained by weighing after 3 h at 550 °C in the muffle furnace. Total N was determined by the Kjeldahl method, and crude protein obtained by using the conversion factor (N x 6.25). Crude fat was analyzed using a Soxhlet extractor, and carbohydrates estimated by the phenol-sulphuric acid method of Dubios *et al* (1956). Ca, Mg, K and Fe were determined by atomic absorption spectrophotometry, P by colometry, Na by flame photometry.

Statistical analysis

Rating results in each treatment of triplicate experiments were subjected to analysis of variance (ANOVA). Tests of significance were carried out with Duncan's multiple range test at 0.5% level of probability.

RESULTS AND DISCUSSION

Pleurotus plumonarius was observed to fruitify on the three substrates used (Plates 1and 2). From week 3 to week 6, there was full ramification of all three substrates by *P. pulmonarius* however, it was observed that banana leaf aided the fastest mycelia growth with full ramification at week 2, compared to corn cob and coconut coir, banana leaf had the highest mean mycelia length with values of 12.00 ± 0.000 which indicated full ramification while corn cob and coconut coir had a mean mycelia length of 7.32 ± 0.006 and 11.18 ± 0.012 respectively at week 2 (Table 1).

Table 1: Mycelia growth of *P. pulmonarius* on three lignocelluloses substrates after six weeks

			Mycelia growth (cm)			
			Weeks			
substrates	1	2	3	4	5	6
Corncob	3.60±0.115[a]	7.32±0.006[a]	12.00±0.000[a]	12.00±0.000[a]	12.00±0.000[a]	12.00±0.000[a]
Coconut coir	3.80±0.231[a]	11.18±0.012[b]	12.00±0.000[a]	12.00±0.000[a]	12.00±0.000[a]	12.00±0.000[a]
Banana leaf	6.60±0.346[b]	12.00±0.00[c]	12.00±0.000[a]	12.00±0.000[a]	12.00±0.000[a]	12.00±0.000[a]

Means of three replicate ± standard error. Values followed by the same letter(s) along each vertical column are not significantly different by Duncan's multiple range test ($P \leq 0.05$).

This observation is in contrast with the report of Oei (2003), who reported that the use of banana leaves is time consuming for large scale production of mushrooms. Table 2 showed that there was significant difference in the yield of *P. pulmonarius* grown on the three substrates with banana leaf having the highest fresh weight of mushroom yield (21.30g±0.0346) followed by corn cob (5.25g± 0.012) and coconut coir (4.30g± 0.145) respectively. Banana leaf also induced the highest dry weight (4.06g±0.581), stalk length (5.90±1.328), biological efficiency (13.14± 4.18) and productivity (2.31±0.00), while coconut coir induced the lowest fresh weight (4.30g±0.145), dry weight (0.43± 0.203), cap length (4.57±0.000), stalk length (3.87±0.000), biological efficiency (2.9±0.000) and productivity (0.50± 0.023) yield respectively. This result could be due to higher nitrogen content in the banana leaf.

Table 2: Yield of *P. pulmonarius* on three lignocelluloses substrates

Substrates	Fresh weight (g)	Dry weight (g)	Length of cap (cm)	Length of stalk (cm)	Biological efficiency (%)	Productivity (%)
Corn cob	**5.25±0.012^{b}**	**0.69±0.289^{a}**	**7.50±0.577^{b}**	**5.78±0.006^{a}**	**6.86±0.080^{ab}**	**0.90±0.023^{b}**
Coconut coir	**4.30±0.415^{a}**	**0.43±0.203^{a}**	**4.57±0.000^{a}**	**3.87±0.000^{a}**	**2.90±0.000^{a}**	**0.50±0.023^{a}**
Banana leaf	**21.30±0.346^{c}**	**4.06±0.581^{b}**	**4.63±0.000^{a}**	**5.90±1.328^{a}**	**13.14±4.18^{b}**	**2.31±0.000^{c}**

Means of three replicate ± standard error. Values followed by the same letter(s) along each vertical column are not significantly different by Duncan's multiple range test ($P \leq 0.05$).

Table 3: Proximate content of *P. pulmonarius* on three lignocelluloses

Substrates	**Crude fat**	**Crude protein**	**Dry matter**	**Crude fiber**	**Ash**
Corn cob	9.76±0.009[a]	21.31±0.006[a]	91.83±0.006[b]	17.67±0.006[b]	9.67±0.006[a]
Coconut coir	14.55±0.006[c]	28.61±0.006[b]	92.67±0.006[c]	15.84±0.006[a]	11.44±0.006[b]
Banana leaf	12.35±0.006[b]	25.41±0.006[c]	90.69±0.006[a]	18.49±0.011[c]	12.66±0.006[c]

Means of three replicate ± standard error. Values followed by the same letter(s) along each vertical column are not significantly different by Duncan's multiple range test ($P \leq 0.05$).

Table 4: Mineral content of *P pulmonarius* on three lignocelluloses substrates

			Minerals (%)			
Substrates	**Na**	**K**	**Ca**	**Mg**	**P**	**Fe**
Corn cob	0.08±0.006[a]	0.38±0.006[a]	0.12±0.006[a]	0.22±0.006[a]	0.28±0.006[a]	0.08±0.006[a]
Coconut coir	0.09±0.06[a]	0.44±0.006[b]	0.13±0.006[a]	0.20±0.003[a]	0.35±0.006[b]	0.10±0.001[b]
Banana leaf	0.13±0.001[b]	0.68±0.006[c]	0.24±0.006[b]	0.38±0.006[b]	0.43±0.006[c]	0.11±0.006[b]

Means of three replicate ± standard error. Values followed by the same letter(s) along each vertical column are not significantly different by Duncan's multiple range test ($P \leq 0.05$).

Plate 1: Fruit Bodies of *P pulmonarius* on banana leaf

Plate 2: Fruit Bodies of *P pulmonarius* on corn cob

Anyakorah and Olatunji (2001) reported cotton waste had the highest yield among several ligninocellulosic wastes used in their study, they indicated that this observation was as a result of higher nitrogen content in cotton waste than in other cellulosic wastes used. Yield result also showed that banana leaf supported the highest fruit body, fresh weight, dry weight, of the three substrates used for this study. Corn cob had the longest length of cap. This observation is in line with the earlier work of Royse *et al* (2004) and Mamiro and Royse (2008) who reported that there are several sources of variations for mushroom size, which include the type of substrate used. Results of nutrient composition of *P. pulmonarius* cultivated on the three substrates showed significant difference in the nutrient composition content of *P. pulmonarius* fruit bodies harvested. Coconut coir was observed to induce the highest percentage of crude protein

(28.61%), crude fat (14.55%) and dry matter (92.67%) respectively while the lowest percentage of crude protein (21.32%), crude fat (9.77%) was recorded on corn cob. Banana leaf was observed to induce the lowest dry matter (90.69%), however, the highest percentage of ash and fiber with mean values of 12.66% and 18.47% were observed on banana leaf. The results on proximate analysis of the mushroom fruit bodies indicated that *P. pulmonarius* fruit bodies harvested on coconut coir and banana leaf had the highest percentage of crude protein, crude fat dry matter, ash and fiber. These could also be as a result of varying carbohydrate or hydrogen content of the substrates as reported by Oei (2003), who noted that mushrooms absorb the content of their substrates, hence the observed difference in the proximate contents of harvested fruit bodies. Although the highest percentage of crude protein was observed in Coconut coir (28.61%), crude protein percentage of harvested fruit bodies on banana leaf was also observed to be high (25.42%) which is in agreement with the report of Miles and Chang (1997) which observed that mushrooms protein content ranged between 25 – 50%.

The mineral content of fruit bodies harvested on banana leaf was observed to be the highest compared to fruit bodies harvested coconut coir and corn cob with values of Na (0.13 ± 0.001), K (0.68 ± 0.006), Ca (0.24 ± 0.006), Mg (0.38 ± 0.006), P (0.43 ± 0.006), Fe (0.11 ± 0.006) while fruit bodies harvested on corn cob was observed to contain the lowest percentage of Na (0.08 ± 0.006), K (0.38 ± 0.006), Ca (0.12 ± 0.006), Mg (0.22 ± 0.006), P (0.28 ± 0.006) and Fe (0.08± 0.006) (Table 4). The result obtained in this research gave Na (0.13%) Phosphorous (0.43%) and this compares relatively with that obtained by Awosanya and Adejumo which ranges between 0.12-0.4% for sodium and 0.10 to 0.40% for phosphorous.

RECOMMENDATION

Results from this research showed banana leaf as the best substrate for *Pleurotus pulmonarius,* hence the need for it to be used in the cultivation of this edible mushrooms thereby reducing agricultural waste and at the same time, helping to reduce malnutrition.

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