

# CULTIVATION OF MUSHROOM (*Pleurotus ostreatus*) USING CORN COBS AND SAW DUST AS THE MAJOR SUBSTRATES

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## ABSTRACT

An investigation was carried out on the cultivation of mushroom (*Pleurotus ostreatus*) using corn cobs and saw dust as the main substrates. Lignocellulosic wastes such as corn cobs and saw dust were packaged inside heat – resistant polythene bags and pasteurized before being seeded with 7.5% w/w millet spawn of *Pleurotus ostreatus* and incubated at room temperature (25°C) for six weeks. Thereafter, they were exposed by incising small stripes on the bag to give a cold shock to initiate fruiting. The result of this study showed that corn cobs had an average yield of 1,248g per flush and saw dust 526.50g per flush. Thus, indicating that saw dust gave a significantly ( $p < 0.05$ ) higher yield (70%) than saw dust (30%). Mushroom cultivation in Nigeria (Developing Country) is of great importance because it converts agricultural and industrial waste (which can pollute the environment) into edible protein; it can serve as a means of generating employment for the Nigeria populace because it can be grown all year round; if exported, mushrooms will be an important source of foreign exchange.

**KEY WORDS:** Mushroom, *Pleurotus Ostreatus*, Saw Dust, Corn Cobs, Substrates

## INTRODUCTION

Mushrooms have been defined as macro-fungi with distinctive fruit bodies, which are visible to the naked eye. Mushrooms belong to the class Basidiomycetes (Pelczar *et al.*, 2003). Mushrooms have long been recognized as food items, delicacy and for their medicinal values. Mushrooms contain all the essential acids including abundant content of lysine (which is too little in cereal grains). Mushrooms contain linoleic acids (unsaturated fatty acids) which are considered desirable for good health. Animal fat is considered hazardous to health because of abundance of saturated fatty acid, while vitamins such as thiamine (B<sub>1</sub>), riboflavin (B<sub>2</sub>), niacin biotic and ascorbic acid (Vit.C) are present in abundance in mushrooms. The mineral contents in mushroom are higher than those of meat, fish, eggs, cheese and most vegetables (Royse, 1996; Park 2001). Mushroom cultivation has a good potential in Nigeria, because there are cheap and available substrates, man – power and ready market. The major substrates for cultivation are lignocellulosic wastes while the minor substrates (additives) are nutritional supplements which are added in small quantities.

Many species of mushrooms in Nigeria are edible, although none appears to be deliberately cultivated for that purpose until recently. The realization of the nutritive therapeutic potentials of mushrooms has awakened interest in this regard and individuals, private companies and government are poised to cash in on this potential revenue earner.

In Nigeria, mushroom production in natural forests is under threat as most of the indigenous species of mushrooms are endangered. This is a serious problem because mushrooms occur naturally in narrow ecological niches within the tropical forests. Thus, most habitats of mushrooms are continuously being destroyed

for agricultural purposes. The introduction of exotic cash crops (cocoa, rubber, cotton, groundnut and oil palm) into the traditional farming in 1950s led to massive destruction of natural forest which are the potential habitats of mushrooms including other non-timber forest products (Kadiri, 1990). In nature, mushrooms have the habit of growing below the ground or within the substrate on which they grow. The fruiting season is usually during cool and moist weather. As a result of this mushrooms can be grown artificially under controlled or semi controlled conditions.

As an answer to solving global food crisis and in consideration of their nutritional value, especially in developing countries, mushrooms are now grown in large scale to meet the nutritional needs of the people (Royse, 1996; Park 2001). Mushrooms can be viewed therefore as a useful source of food supplement and considered to be especially useful in predominantly vegetarian diet (Hayes, 1972).

Many species of mushrooms such as *Pleurotus*, *Agaricus*, *Lentinus*, *Flammulina* and *Volvariella* are cultivated worldwide (Chang and Miles, 1989). *Pleurotus* is generally called the oyster mushroom. It could be whitish gray, yellow and blue in colour. The commonly cultivated species of *Pleurotus* included *P. ostreatus*, *P. Sajorcaju*, *P. Sipidus* and *P. cystichosus* (Paul and Chilton, 1983).

There is evidence to show that mushroom cultivation can be costly (Shroeder *et al.*, 1970). Currently, according to Oei (1996), countries such as China, Japan and Taiwan have developed many methods to grow mushrooms even with limited resources. Hence individuals and extension workers are now using cheap and available materials to cultivate mushrooms (Egbere *et al.*, 2003). The cultivation of different species of *Pleurotus ostreatus* on polar chips and saw dust mixtures (Kostov, 1988), wood (Suprapti,

1989, Cotton seed hulls (Sun and Yu, 1989) saw dust (Stamets and Chilton, 1983) serve to highlight this point. This paper reports the basis and procedure for cultivation of *Pleurotus ostreatus* using locally sourced materials such as saw dust and corn cobs as a pragmatic translation of the present national interest in mushrooms cultivation into practical reality. The aim of the study is primarily to educate farmers on how to grow mushrooms, which apart from the nutritional benefits, will help using their improve their socio – economic well being.

## MATERIALS AND METHODS

### Sample Collection.

Three 50kg bags each of saw dust and corn cobs were obtained from sawmill and from Federal College of Forestry respectively, all located in Jos Plateau State, Nigeria. The mushroom spores were also obtained from College of Forestry, while the millet grains used for the spawn production were bought from the market.

### Experimental Site

The project was carried out in the biological laboratory of the Federal College of Forestry in Jos, Plateau State, Nigeria. The Jos Plateau is located in the central part of Nigeria between latitudes 8° 30' with 10° 10'N and longitudes 8° 20' and 9° 30'E with a surface area of about 9,400km<sup>2</sup>. It has an average elevation of about 1,250 meters above sea level and stands at a height of about 600 meters above the surrounding plains. The climate is the wet and dry type and classified as tropical rainy climate (Udo, 1990). Temperature on the Jos Plateau and its environs are lower than the surrounding areas with minima of 15.5°C to 18.5°C to maxima of 27.5°C to 30.5°C (Udo, 1990). Average rainfall in the study area is 1, 411mm per year.

### Spawn Preparation

Spawn are to mushrooms what seeds are to plants. Two types of spawn exist; the grain mother spawn and the planting spawn, while the former produce the planting spawn, the later is the actual planting spawn used in mushrooms cultivation. Spawn making is putting mycelium of desired mushroom in a suitable sterilized substrate under aseptic condition (Quimio *et al.*, 1990). This serves as the planting material in mushroom. Materials such as sawdust, *Sorghum bicolor* (guinea corn), *Triticum aestivum* (wheat) *Pennisetum tyhiodes* (millet) can be used to produce spawn. In this study, millet grains were used for spawn production. About 10kg of grains were collected and winnowed to get rid of chaff and spoilt seed. They were then thoroughly washed and boiled for 10 minutes until they became tender but were not allowed to break. The grains were then allowed to cool. An equivalent amount of calcium

carbonate (CaCO<sub>3</sub>) was added to the grains to prevent them from sticking together.

The grains were loosely packed in 10 empty salad cream bottles that could withstand heat. The bottles containing the grains were plugged with non absorbent cotton wool, covered with aluminum foil paper and sterilized in an autoclave for one hour at a temperature of 121°C. The bottles were allowed to cool and made free of condensed water before inoculating *Pleurotus ostreatus* mycelia. The inoculated bottles were incubated at room temperature (25°C), and the bottles were shaken every 3-4 days for one minute to loosen the grains being colonized by growing mycelia (Quimio, 1990).

### Substrate Preparation and Mushroom Cultivation

The procedures of producing mushrooms as described by Peter (1996) were adopted in this study. The experimental design used in this study was completely randomized block design. The major substrates for cultivation were lignocellulosic wastes, while the minor substrates (additives) were nutritional supplements which were added in small quantities. About 1,200kg each of the selected substrates saw dust, and corn cobs were soaked in water separately to enable them have about 70% water content. Soaking in water may be for 8-24hr with 1 or 2 changes of water to prevent the substrates from fermenting before pasteurization process. Soaked substrate were drained of excess water until 70% water content was attained. Each substrate was then packed into 10 trial heat-resistant polythene bags and used as synthetic logs (each trial having 5 replicates). These were pasteurized by heating in 8 litres of water contained in 12 litres pot using fuel wood. Pasteurization destroyed disease microbes, while leaving useful microorganisms. Prior to pasteurization, additives (about 1% urea in solution and 2% lime) were added to increase the protein and alkaline contents of the substrates.

After sterilization the different substrates in the bags were spawned with 7.5% millet spawn and incubated (spawn running) at room temperature for six weeks after which they were exposed and given a cold shock to initiate fruiting. The polythene bags were then cut open to expose strips of the saw dust and corn cobs to give room for normal shape fruit bodies. Mature mushrooms were harvested manually by hand plucking; this was done in flushes of one, two, three and four. The wet weight of the first, second, third and fourth flushes in each replicate were weighed using laboratory weighing balance, and their arithmetic means recorded. There was constant wetting of the set up to prevent drying and to create high humidity needed. The experimental layout of *Pleurotus ostreatus* is shown in Table 1.

**Table 1:** Experimental Layout of *Pleurotus ostreatus* Cultivation.

Substrates	Trial bags in five replicates									
Corn cobs	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>	T <sub>7</sub>	T <sub>8</sub>	T <sub>9</sub>	T <sub>10</sub>
Saw dust	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	T <sub>5</sub>	T <sub>6</sub>	T <sub>7</sub>	T <sub>8</sub>	T <sub>9</sub>	T <sub>10</sub>

### Measurement and Adjustment of *Pleurotus ostreatus* growth condition

**Temperature:** The temperature of the substrate contained in the bags used in growing mushrooms was determined by inserting it into the bags.

**Relative Humidity:** the relative humidity (R.H.) of the mushroom was maintained constantly at 90-98% by constant water spray. The R.H. was measured using a hygrometer.

**Proximate Analysis:** The proximate composition of the substrates supplements and mushroom yields were determined according to procedures described by Association of Official Analysis Chemists (AOAC, 1984).

**Statistical Analyses:** The data were analyzed using analysis of variance (ANOVA) according to the method described by Kelly and Onyeka (1992). LSD test was used to determine the significant difference between treatment means.

### RESULTS AND DISCUSSION

**General Observation:** It was observed that the colour of *Pleurotus ostreatus* cultivated on corn cobs and sawdust were both grayish at early stages of fruiting and creamy at maturity. Out of the twenty trials, 6 bags were grossly colonized by contaminating moulds with little or no *Pleurotus* growth. The 6 bags were discarded and research efforts were then concentrated on the remaining 14 trials that had positive yields. Plates 1 and 2 show the fruiting *Pleurotus* grown on corn cobs and sawdust respectively



Plate 1: *Pleurotus Ostreatus* Cultivated on Corn cobs.



Plate 2: *Pleurotus Ostreatus* Cultivated on Saw dust.

The temperature readings of experimental mushroom bags are shown in Table 2. During the experiment, temperature of the substrates in bags ranged from 22-40°C for corn cobs and 19-35°C for saw dust (Table 2). There was a general steady increase in temperature in both substrates at the initial stage. This increase in temperature peaked at 10 and 12 days before declining for the corn cobs and sawdust respectively. According to Peter (1996), increase in temperature is due to rapid fermentative degradation of the substratum by the mushrooms so as to initiate and

anchor the mycelia to the substrate. This degradation results in heat generation. After proper anchorage of the mycelia (at the mycelia initiation room) less degradation ensues and growth thrives on already degraded substrate at the root of the mushrooms. The result in Table 2 revealed that the mean temperature of the corn cobs was higher than those of their counterpart's sawdust bags. It could imply that the corn cobs may be more easily degraded by the enzymatic action of the mushroom mycelia resulting to greater fermentative degradation and higher heat production (Oei, 1996).

**Table 2:** Temperature Readings of Experimental *Pleurotus Ostreatus* Substrates during Cultivation Period of Six Weeks.

Substrate	Temperature Range (°C)	Mean temperature	SD
Corn cobs	22-40	26.38	± 0.31
Saw dust	19-35	30.24	± 0.28

SD = Standard deviation

The results of the proximate analyses of the raw waste materials using growing *Pleurotus ostreatus* are shown in Table 3. Although, the results in Table 3 showed that the protein content of corn cobs was slightly

higher than that of saw dust, the statistical analysis (analysis of variance) showed that there was no significant difference ( $p > 0.05$ ) between the protein contents of the substrates.

**Table 3: The Proximate Composition of the Mushroom Substrates.**

Substrate	Moisture (%)	Crude protein (%)	Lipid (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
Corn cobs	10.41	1.50	3.06	23.30	12.10	25.30
Saw dust	9.20	1.32	1.82	34.10	23.14	36.25

The production yields of *Pleurotus ostreatus* on corn cobs substrate during each flush was significantly higher ( $p < 0.05$ ) than that of their sawdust counterparts (Table 4), with the first flushes of both substrates having the highest yield as a result of higher nutrient content

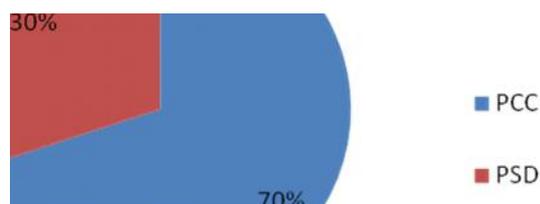
present in them at the initial stage. Statistically, mushroom yield obtained from corn cobs was significantly higher ( $p < 0.05$ ) than values obtained from saw dust with corn cobs having average yield per flush of 1.249kg and saw dust 0.527k

**Table 4:** Production Yield of *Pleurotus ostreatus* Harvested in Flushes from Corn Cobs and Saw Dust.

Substrate	Flushes (g)				Total yield (kg)	Average yield per flush (kg)
	1	2	3	4		
Corn cobs	2.064	1.805	0.690	0.436	4.995	1.249
Saw dust	0.930	0.764	0.269	0.143	2.106	0.527

The total percentage yields of the mushroom cultivated on corn cobs and saw dust are shown in Fig. 1. The results clearly showed that corn cobs had 70% yield which was significantly higher ( $p < 0.05$ ) than 30% from saw dust. The results of the present study is contrary to the result obtained by Victoria and Agina

(2002), in which pasteurized saw dust obtained from white wood gave a better yield of the mushroom than the other substrates they used for cultivating *Pleurotus ostreatus*. This variation in results compared with the present study could be due to differences in wood types (Quimoi *et al.*, 1990)

**Fig. 1:** Percentage Yield of *Pleurotus ostreatus* Harvested from Corn Cobs (PCC) and Saw Dust (PSD) after a Period of Six Weeks.

The results of the proximate analyses of the mushroom cultivated with corn cobs and saw dust substrate is shown in Table 5. It shows that the mushrooms harvested from both substrates yielded high protein and low fat values. The result also showed that with very low protein - containing agro - plant waste materials i.e. 1.50% and 1.32% in corn cobs and saw dust respectively (Table 3) a significant increase ( $p < 0.05$ ) in protein content of edible biomass (mushrooms) were obtained (29.84% and 29.61% in

corn cobs and saw dust respectively (Table 5). The high protein conversion rate of *Pleurotus ostreatus* makes it a potential source of single cell protein (SCP) or edible biomass for the tropics. It is of interest to note that corn cobs gave the highest cultivation yield of *Pleurotus ostreatus* compared with saw dust. These results compare favourably with previous results in which sawdust and wood were used for mushroom cultivation (Khana *et al.*, 1991).

**Table 5:** Proximate Composition of Sun dried *Pleurotus ostreatus* Harvest from Corn cobs and Saw Dust after a Period Six Weeks.

Substrate	Moisture (%)	Crude protein (%)	Lipid (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
Corn cobs	10.06	29.84	1.92	2.12	10.30	43.24
Saw dust	10.03	29.61	1.94	2.10	10.45	42.36

## CONCLUSION

It could be concluded from the results of this investigation that for maximum commercial gain in mushroom farming, corn cob substrate is recommended for mushroom farmers for better yield of *Pleurotus ostreatus* than saw dust. It has become necessary therefore, that the government at all levels in collaboration with Ministry of Agriculture and Ministry of Science and Technology in Nigeria should create awareness on the production and nutritive value of mushroom. Furthermore, farmers in rural and urban areas should be empowered financially by the government in providing microcredit scheme to support mushroom farming in the country for greater economic returns.

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