# EFFICACY OF WHEAT STRAW AND COTTON WASTE AS SUBSTRATES IN THE PRODUCTION OF THE EDIBLE OYSTER MUSHROOM (Pleurotus ostreatus Florida)

By

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***ABSTRACT***

*Wheat straw and cotton waste were used as substrates. Some natural additives, nitrogen and carbon sources were used as nutrient supplements to enhance mycelial growth of Pleurotus ostreatus (Florida).Minced wheat straw and cotton waste substrates were soaked in boiled water and excess water was squeezed out using a clean muslin cloth. Supplements were added to the substrates and were autoclaved. Pleurotus osreatus was inoculated. Wheat straw was found to be a better substrate for mycelia growth than cotton wastes. The natural additives and carbon sources grew better than the nitrogen additives on both substrates. Malted yellow maize, D-fructose and methyl cellulose can best be used as additives to promote mycelia growth of Pleurotus ostreatus.*

**Key words:** Pleurotus ostreatus, supplements, mycelia, wheat straw, cotton waste.

## INTRODUCTION

Mushrooms have become attractive as food and sources of pharmaceuticals used for medicinal purposes, which are prepared either as hot extracts, concentrates or in powdered form (Smith, 2002). The most important use of Mushroom is as a source of food. They are considered to be good sources of digestible proteins, carbohydrates, dietary fiber and all essential acids (Barros, et al., 2007). Edible Mushrooms have been treated as special kinds of food since earliest times (Oei, 1996, 2005). Mushrooms are of great economic importance in all parts of Nigeria, they are used in making soup to replace melon in Okra or vegetable soup (Zoberi, 1972, 1973). Mushrooms are useful in preventing diseases such as hypertension, hypercholesterolemia and cancer (Mau et al., 2002). Edible Mushrooms have been treated as special kinds of food since earliest times (Oei, 1996). It is also beneficial to forest decomposition. The forestry mushrooms are nature's most active agent in the disposal of forest waste materials (Bahl, 1988; Kadiri et al., 2008). Mushroom compost is moisturize and covered to avoid evaporation of water. High humidity is maintained by regular watering (Barros, et al., 2007). Mushrooms are fruiting structures of large fungi. The function of fruiting body is to produce spores for spawning. Pleurotus Osteratus (Florida) is an edible oyster Mushroom that is indigenous to hot subtropical and tropical regions. It plays key roles in nutrient recycling, human nutrition and bioremediation of waste materials (Kashangura et al., 2006). Productions of oyster mushrooms are a saprophytic process as they obtain their nutrients by decomposing various agricultural by-products (Asami and Seto, 2004).

Cultivation of mushroom in commercial scale started in the 17th century. Mushroom have been cultivated on large scale in the united kingdom, Holland, France, United states, China and Japan(Chang,2003).Mushroom cultivation has indeed extended during the last decades to some African countries. Akueshi (1997) reported that, in Nigeria there are deliberate efforts by the federal Government to popularize the production of mushrooms for revenue earning and utilization of food supplements and is hoped that with time individuals, households and entrepreneurs will embark on the production of Mushroom for exportation from Nigeria to other countries.

Cultures of edible Mushroom and spawn production has been introduced at the Federal Institute of Industrial Research, Oshodi, Lagos and Federal College of Forestry Jos. Mushrooms can grow wild and pure culture was only possible through scientific methods (Olatunji, 1998). Vegetative organic residues are used for Mushroom compost preparation. Rice, wheat, barley straws and residues of cotton are principally employed (Alofe et al.,1998).Organic supplements are usually added to substrates to provide organic sources of nitrogen (Upadhay et al., 2003). Akueshi (1997), reported that there have been deliberate efforts by the Federal Government to popularize production of mushrooms to increase income generation and its utilization as food. Oyster mushrooms have been preferred by most mushroom growers all over the world because of its flexible temperature and other environmental requirements. It is also said to have more cultivated known species than the other mushrooms (Kuforiji et al., 2003). Commonly cultivated types of oyster mushroom are Pleurotus ostreatus, Pleurotus sapidus, Pleurotus ergi and Pleurotus pulmonarius (Chang, 1993). The fruit bodies of mushrooms are used to produce suede like material from which hats, various articles of handbags, pictures frames, costume decorations and bottle corks are made (Bahl, 1988). The best mycelial production is obtained by inoculating the fungus from pure culture that is isolated from artificial agar medium by means of an aseptic withdrawal of fruiting body fragment placed directly on the agar medium (Kadiri, et al., 2009). The culture obtained in this way is used as a spawn which is inoculated on the mushroom compost of cellulolatic material that is from straw of maize, rice, cotton waste and saw dust (Kadiri et al., 2004). Additives or nutrient supplement are organic supplement such as glucose, peptone, sucrose, rice bran, maize chaff and spent grain are added to substrates to provide organic sources of nitrogen for formation of fruiting bodies in mushroom (Upadhyay, 2002). This study was designed to evaluate the effects of adding some additives on wheat straws and cotton waste for the growth of edible mushroom Pleurous ostreatus (Florida).

## MATERIALS AND METHODS

Pleurotus ostreatus (Florida) was used throughout the experiement. It was cultured on potato dextrose agar (PDA) in the laboratory. The wheat straw and cotton waste were obtained from the Department of Biological Sciences, Bayero University, Kano, Nigeria. The sundried wheat straw was cut into small pieces of about 0.1 – 1.0cm in length using hand guillotine. The wheat straw and cotton waste were separately soaked in boiled water for an hour and the excess water was squeezed out using a muslin cloth. The substrates were filled into boiling tubes in triplicates up to 10cm height each. The boiling tubes were covered with aluminum foil and autoclaved at103 kpa for 15 minutes (Sinden et al., 1962; Poppe, 2010). The inoculation of the Pleurotus ostreatus was done in the inoculation chamber which has been sterilized by mopping 10% formalin two weeks prior to the day of inoculation. The autoclaved boiling tubes were inoculated with mycelia discs obtained from culture of P. ostreatus using sterilized 5 mm cork borer and sterilized inoculating needle. The inoculated boiling tubes were incubated in an incubator at 30+ 20C which had earlier been sterilized with 10% formalin (Upadhyay et al., 2002)

## COLLECTION OF ADDITIVES

The natural additives were obtained from the Ecological garden of Bayero University farms and some were bought from the local market around the University. The cereals were malted before being used. This involved soaking of 200g of each cereal in 250ml of distilled water for two days in a refrigerator at 15oC.The soaked cereals were separately sown in glass Petri dishes filled with distilled water. These were kept in the laboratory for germination to take place after 2 -3 days. Germinated cereals were dried in an oven at 800C for 2 days. The oven dried seedlings were powdered with pestle and mortar and the powder was used as additives (Fasidi and Kadiri, 1993). To the substrates were added malted sorghum, malted yellow maize, malted white maize, malted millet, malted rice, maize chaff, sorghum chaff, poultry feed, poultry dung, cow dung, horse dung, rat pellets, yam peels and rice bran at 10% 20% and 30% additive levels to 90g, 80g, and 70g of substrate respectively (Nwanze et al .,2005). The substrates containing the different additives at various levels were filled into 3 boiling tubes and covered with aluminum foil. The control experiment consisted of the substrate soaked in water with no additive. The substrates were filled into boiling tubes and covered with aluminum foil. All the boiling tubes were autoclaved at 103 pa pressures for 15 minutes and inoculated after cooling with 5mm mycelia discs of P. ostreatus. The inoculated boiling tubes were incubated at 30 + 2oC for 5- 10 days, and the linear mycelia extension was measured with a ruler. In the case of additives from nitrogen sources, 1g, 2g and 3g was added to 99g, 98g and 97g, of the substrates respectively. Each preparation was filled into 3 boiling tubes and the boiling tubes were covered with aluminum foil. The control experiment consisted of the substrate that had the best mycelia growth from the natural additives and substrate that had no nitrogen sources added to them. Similarly, additives from carbon sources, 1g, 3g and 5g were added to 99g, 97g and 95g of the substrate respectively. Autoclaving as above, the inoculated tubes were incubated at 30+20c for 10 – 18days and the linear mycelia growth was measured with a ruler (Pathak et al., 2009)

## RESULTS AND DISCUSSION

The fresh mushroom yield or biological efficiency of a species is directly related to strain, substrate nutrition and growth conditions. Sustainable oyster mushroom production can be achieved by employing cultural practices which optimize and integrate nutrient management. Agricultural residues used for oyster mushroom cultivation provide most of the nutrients and vitamins for growth. Carbon is readily available from cellulose, hemicellulose and lignin from straw, but nitrogen occurs mainly in a bound form and is not available until it is enzymatically released. Various workers have also reported that Pleurotus spp have the capability to fix atmospheric nitrogen (Upadhyay et al., 2002). Wheat straw and cotton waste were found to be good substrates for mycelial growth with wheat straw being better than cotton waste (Table 1). The summary of the result (Table 2 – 4) indicates that additives with wheat straw showed a better mycelial growth than with cotton waste. Yield increase may be due to extra amino acids or proteins available to the mushroom mycelium (Sinden, et al., 1962). Nitrogen additives with cotton waste that showed little or no growth except with malted yellow maize and Ammonium nitrate with mycelia growth of 1. 0 ± 0 at 1%, 2% and 3% additive level. The malted yellow maize showed better mycelial growth than all other additives. At 30% additive level, poultry feed did not show any mycelial growth with the used substrates. As the additive level was increased, from 10% to 30% there was a corresponding decrease in mycelial growth (Table.1) Effect of nitrogen sources as additives on the mycelia growth of P. ostreatus. Wheat straw was consistently better than cotton waste in supporting mycelia growth at 1%, 2% and 3% additions (Table 3), Casein 1 – Histidine and yeast extract inhibited mycelial growth at all additive levels except yeast extract that showed a slight mycelial growth at 3% (Table 3). As additive concentrations increased, mycelial growth decreased except for ammonium nitrate that had the reverse trend (Table 3). Wheat straw mixed with nitrogen sources at 1%, 2% and 3% additive level showed better mycelia growth than the control and showed best mycelial growth with malted yellow maize, DL aspartic acid and Urea, than when cotton waste was mixed with three nitrogen sources at 1%, 2 % and 3% additive level.

Effect of carbon sources as additives on mycelia growth P. ostreatus at 1% 3% and 5%, wheat straw was better than cotton waste in supporting mycelial growth except for lactose and arabinose (Table 4). More so, cotton waste with arabinose was better in. supporting mycelia growth than wheat straw. As the additive level increased from 1% to 5%, mycelial growth decreased except for lactose which had the opposite trend (Table 4). Wheat straw gave a better mycelia growth than cotton waste with methyl cellulose and D. Fructose being better in mycehial growth than the control (Table 4).

From the findings in the study, both wheat straw and cotton waste were good for culturing and production of edible mushroom Pleurotus ostreatus (Florida), with wheat straw being better. Supplementation of wheat straw with organic sources are suitable for P. ostreatus var florida.

**Table 1: Mean mycelial growth (cm+S.E) of Pleurotus ostreatus (Florida) in Cotton waste and Wheat straw at 10 days after inoculation**

| Chosen substrates | Mean mycelia growth (cm) |
|---|---|
| Wheat straw | 9.+ 0.3 |
| Cotton waste | 7.+ 0.2 |

**Table 2: Mean mycelial growth (cm ± S.E) of Pleurotus ostreatus (Florida) in wheat straw and Cotton waste substrates mixed with agricultural sources as additives at 10 days, 14 days and 18 days after inoculation.**

| Natural additives | SUBSTRATES AND ADDITIVE CONCENTRATION | | | | | |
|---|---|---|---|---|---|---|
| | 1% addition | | 3% addition | | 5% addition | |
| | Wheat straw | Cotton waste | Wheat straw | Cotton waste | wheat straw | Cotton waste |
| Cow dung | 7.7±0.6 | 4.7±0.2 | 4.4±0.1 | 2.3±0.2 | 4.0±0.2 | 0.7±0.1 |
| Horse dung | 4.7±0.6 | 4.7±0.4 | 3.3±0.1 | 2.0±0.3 | 2.7±0.2 | 1.0±0.0 |
| Poultry dung | 5.3±0.2 | 1.0±0.0 | 4.8±0.4 | 1.0±0.0 | 2.3±0.0 | 1.5±0.2 |
| Yam peels | 4.7±0.3 | 5.3±0.2 | 4.0±0.3 | 2.1±0.2 | 1.3±0.1 | 1.0±0.1 |
| Rat pellets | 5.3±0.4 | 2.7±0.1 | 3.8±0.2 | 0.5±0.0 | 1.8±0.0 | 0.3±0.0 |
| Poultry feed | 7.8±0.6 | 6.7±0.3 | 1.1±0.0 | 4.3±0.2 | NO GROWTH | NO GROWTH |
| Rice bran | 7.8 ±0.2 | 5.7±0.2 | 5.7±0.4 | 3.2±0.2 | 4.4±0.1 | 2.3±0.3 |
| Malted millet | 7.8±0.4 | 5.3±0.4 | 4.1±0.1 | 3.3±0.0 | 1.7±0.2 | 1.3±0.1 |
| Malted sorghum | 7.0±0.3 | 6.5±0.5 | 6.7±0.3 | 3.6±0.2 | 6.3±0.5 | 1.5±0.0 |
| Malted rice | 7.3±0.3 | 6.3±0.4 | 5.0±0.5 | 2.3±0.0 | 3.0±0.2 | 1.8±0.2 |
| Malted white maize | 7.7±0.2 | 5.2±0.4 | 5.4±0.3 | 2.8±0.4 | 3.5±0.2 | 2.3±0.3 |
| Malted yellow maize | 8.3±0.2 | 5.3±0.2 | 4.3±0.2 | 2.7±0.2 | 3.2±0.1 | 2.3±0.0 |
| Sorghum chaff | 5.9±0.3 | 4.7±0.1 | 3.4±0.1 | 3.3±0.1 | 2.3±0.0 | 2.0±0.3 |
| Maize chaff | 7.8±0.3 | 5.3±0.2 | 4.4±0.5 | 2.9±0.3 | 3.5±0.0 | 1.0±0.0 |
| Control | 7.3±0.6 | 3.4±0.0 | 5.2±0.4 | 2.2±0.1 | 3.7±0.4 | 1.2±0.1 |

**Table 3: Mean mycelial growth (cm ± S.E) of Pleurotus ostreatus (Florida) in wheat straw and cotton waste substrates mixed with nitrogen sources as additives at 10 days, 14 days and 18 days after inoculation.**

| Natural additives | SUBSTRATES AND ADDITIVE CONCENTRATION | | | | | |
|---|---|---|---|---|---|---|
| | Wheat straw | Cotton waste | Wheat straw | Cotton waste | wheat straw | Cotton waste |
| Malted yellow maize | 8.7±0.6 | 1.3±0.1 | 4.2±0.4 | 1.0±0.0 | 4.0±0.0 | 0.5±0.0 |
| Casein | No growth | No growth | No growth | No growth | No growth | No growth |
| DL-aspartic acid | 8.0±0.3 | No growth | 7.8±0.3 | No growth | 7.6±0.3 | No growth |
| Ammonium sulphate | 4.7±0.2 | No growth | 4.6±0.2 | No growth | 3.2±0.1 | No growth |
| Sodium nitrate | 7.3±0.5 | No growth | 5.8±0.2 | No growth | 5.2±0.4 | No growth |
| Ammonium nitrate | 5.7±0.3 | No growth | 5.5±0.0 | No growth | 4.5±0.2 | No growth |
| Potassium nitrate | 4.5±0.3 | 1.4±0.1 | 5.9±0.3 | 0.5±0.0 | 6.7±0.4 | No growth |
| L-Histidine | 2.8±0.1 | No growth | 2.5±0.1 | No growth | 2.3±0.0 | No growth |
| Yeast extrat agar | No growth | No growth | No growth | No growth | No growth | No growth |
| Peptone | No growth | Not growth | No growth | No growth | 0.4±0.0 | No growth |
| Urea | 1.2±0.1 | No growth | 0.5±0.0 | No growth | 0.5±0.0 | No growth |
| Control | 9.2±0.2 | No growth | 8.5±0.4 | No growth | 7.9±0.5 | No growth |
| | 7.8±0.0 | 4.7±0.4 | 6.8±0.2 | 4.2±0.2 | 6.8±0.5 | 4.2±0.3 |

**Table 4: Mean mycelial growth (cm ± S.E) of Pleurotus ostreatus (Florida) in wheat straw and Cotton waste substrates mixed with carbon sources as additives at 16 days, 14 days, and 6 days after inoulation.**

| Carbon Sources | SUBSTRATES AND ADDITIVE CONCENTRATION | | | | | |
|---|---|---|---|---|---|---|
| | 1% addition | | 3% addition | | 5% addition | |
| | Wheat straw | Cotton waste | Wheat straw | Cotton waste | wheat straw | Cotton waste |
| D-glucose | 7.0±0.3 | 5.3±0.0 | 6.7±0.3 | 4.2±0.2 | 6.7±0.3 | 4.0±0.3 |
| Lactose | 2.2±0.0 | 2.3±0.3 | 0.8±0.0 | 3.0±0.0 | 0.2±0.0 | 4.5±0.0 |
| Maltose | 5.7±0.2 | 5.5±0.2 | 5.4±0.3 | 5.0±0.3 | 5.2±0.4 | 4.0±0.1 |
| Abrabinose | 3.8±0.2 | 6.6±0.4 | 3.5±0.3 | 6.3±0.3 | 2.8±0.1 | 6.3±0.2 |
| Mlated yellow maize | 6.0±0.5 | 5.6±0.1 | 5.8±0.1 | 2.8±0.1 | 5.5±0.5 | 1.5±0.0 |
| (The best in Table 2) | 9.0±0.6 | 2.3±0.0 | 7.3±0.4 | 2.1±0.2 | 7.2±0.7 | 2.0±0.0 |
| Methyl cellulose | | | | | | |
| D-galactose | 5.5±0.3 | 5.3±0.2 | 5.6±0.1 | 5.6±0.4 | 5.9±6.1 | 5.6±0.4 |
| Sucrose | 5.5±0.0 | 3.7±0.4 | 6.2±0.2 | 3.4±0.1 | 6.3±0.0 | 2.0±0.1 |
| D-fructose | 8.8±0.2 | 7.2±0.5 | 8.0±0.3 | 6.2±0.2 | 7.0±0.3 | 6.0±0.0 |
| Starch | 5.6±0.4 | 5.0±0.3 | 5.0±0.3 | 4.5±0.5 | 4.7±0.4 | 4.2±0.2 |
| Control | 7.5±0.5 | 5.3±0.2 | 6.8±0.4 | 4.2±0.4 | 6.3±0.3 | 4.0±0.3 |

**Conclusion**

Sugars could be added to the substrates as natural and synthetic additives in order to enhance mycelial growth of P.ostreatus (Florida).

**Recommendation**

The results obtained in the study could be used in composts formulation for fruit body production of Pleurotus ostreatus (Florida) to boost food production and to increase income generation to our economy.

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