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Cultivation, Yield and Nutritional Value of Oyster Mushroom Cultivated on Two Lignocellulosic Wastes

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Abstract: The yield and proximate composition of *Pleurotus ostreatus* were evaluated using corncob and sawdust substrates to determine the yield and nutritional status of the mushroom as affected by the varying substrates. *Pleurotus ostreatus* was cultivated following sequential steps of substrates composting, bagging, sterilization of bagged compost, spawning, incubation, and cropping. Results indicated that *P. ostreatus* cultivated on corncob substrate had the highest value for stipe length and diameter, pileus thickness, fresh weight and biological efficiency. However, *P. ostreatus* harvested on sawdust substrate had the highest pileus diameter ($P<0.05$). Additionally, the highest amount ($P<0.05$) of crude fat (2.22%), protein (28.40%), crude fibre (8.69), carbohydrates (46.38%) were recorded on fruiting bodies harvested from corncob substrate while higher ash (3.12%) and moisture contents (8.50%) were found in fruit bodies harvested from sawdust substrate. Consequently, the corncob substrate produced fruiting bodies with better yield and nutritional value ompared to the sawdust substrate. Therefore, corncob substrate could be exploited as alternative substrate to wood sawdust for more sustainable production of oyster mushroom (*P. ostreatus*).

Keywords: *Lignocellulosic* wastes, oyster mushroom, Bioconversion of agro-wastes

Introduction

The rapid increase in world population growth rate coupled with technological advancements, waste disposal and management constitute serious problem in the developing countries [1]. Lignocellulosic wastes constitute a major portion of plant biomass and are generated in huge amounts annually in various sectors like agriculture, forestry and the food industry. These wastes consist of rich organic compounds and are worthy of being recovered and transformed [2]. Solving the problem of lignocellulosic agricultural wastes can be realized by promoting a biotechnological process that involves the use of the Basidiomycetes. In Nigeria, amongst the most achievable and financial strategy for the bioconversion of agro-lignocellulosic wastes is through the cultivation of edible mushrooms, these edible mushrooms are high in nutritional value, as sustenance as well as in customary drug [3].

Pleurotus ostreatus, also known as the pearl oyster mushroom, is one of the most widely cultivated oyster mushrooms. The mushrooms have a tender consistency and a mild taste which is sweet and woody [4]. In the natural environment, *P. ostreatus* grows on decaying substances, requiring carbon, nitrogen, and micro minerals as their nutritional sources. Kumla *et al.* reported that *Pleurotus* mushroom species are the most efficient species at decomposing a complex lignocellulose substrate from agricultural waste using lignocellulosic enzymes into a simpler compound as their nutrition source [5].

Proper use of these agro-industrial wastes as substrates for mushroom cultivation could improve the economic status of the farmers, contribute to alleviating nutritional problems and would reduce environmental pollutions [6]. Mushrooms cultivation is the most cost-effective biotechnology available today for recycling lignocellulose organic waste which combines the production of food high in protein with pollution prevention. The nutritional value of mushrooms and their potential health benefits are becoming widespread awareness around the globe. Edible mushrooms are regarded as a significant source for the human diet worldwide, along with fruits and vegetables. Proteins, carbohydrates, dietary fiber, water-soluble vitamins, vital amino acids, and minerals are abundant in *Pleurotus* [7].

Mushroom growing is an eco-friendly activity as it utilizes the wastes from agriculture and it in turn produces fruit bodies with excellent and unique nutritional and medicinal attributes [8]. Cultivation of edible mushrooms might be the only current process that combines the production of protein-rich food with the reduction of environmental pollution [9]. Oyster mushroom can grow on a wide variety of substrate. However, the yield and the quality of oyster mushroom depend on the chemical and nutritional content of substrates [10]. The potential shortages of sawdust and high potential of other agro-waste residues are the reasons why we need to identify alternatives for sustainable cultivation of oyster mushrooms. This study was conducted to compare the effect of two different lignocellulosic wastes (corncobs and sawdust) on the growth, yield, and nutritional composition of oyster mushroom.

Materials and Methods

Experimental site

The mushroom cultivation was carried out at the Mycology Laboratory Department of Crop Production and Protection, Obafemi Awolowo

University, Ile-Ife. The site is located on latitude 07^{o} 28'N, longitude 04^{o} 33'E and on the altitude of 244m above sea level.

Mushroom cultivation

Source of spawn and growth substrates

The pure culture of the fungus *Pleurotus ostreatus* var. *florida* and corncobs were obtained from mushroom production unit, Mycology laboratory and teaching and research farm of Faculty of Agriculture, Obafemi Awolowo University (OAU) Ile-Ife respectively. While the sawdust was collected from Olorunsogo sawmill in Modakeke, Osun State, Nigeria. The pure culture of the mushroom was sub-cultured on potato dextrose agar (PDA).

Spawn preparation

White Sorghum grains were used to prepare the mother spawn. Five Kilogrammes of the white sorghum grains were sorted out from unwanted materials, washed to remove contaminants and excess water drained. The grains were parboiled for 30 minutes, drained of excess water and allowed to cool. Aliquots of the soaked grains were weighed and $CaCO_3$ and $Ca(OH)_2$ was added in the ratio 2:1% to regulate the pH of the grains. They were then filled into labelled sterilized bottles, corked with cotton wool and aluminium foil paper and sterilized at 121°C and 15 lbs pressure for 15 minutes. After cooling, the bottles were inoculated with pure culture of *P. ostreatus* var. *florida* under aseptic conditions and incubated at room temperature (28±2°C) in dark cupboards and monitored for mycelia growth [11].

Substrate preparation for fruiting body production

The substrates used in this research were corn cob (CC) and sawdust (SD). The corncobs were chopped into bits of about 3-4 cm in diameter and the dry weight measured and recorded. Each substrate (corncobs and sawdust) were soaked in water and excess water squeezed out. $CaCO_3$ (2%) and $Ca(OH)_2$ (1%) were thoroughly mixed with the substrates in the ratio 2:1% for optimization and also to adjust the pH to 7.5 for optimum mycelia colonization. The substrates were weighed and put into transparent polypropylene bags (500 g per bag). The bags were sterilized in an autoclave at 121°C and 15 lbs pressure for 15 minutes. After cooling, the bags were inoculated with pure culture of *P. ostreatus* var. *florida* under aseptic conditions and incubated at room temperature (28±2°C) in dark cupboards for 14 days and monitored for mycelia growth. After full ramification of the substrates by the mycelia of the mushroom, they were brought out for pin head formation and the polypropylene bags were removed to allow fruiting. The fully ramified substrates were exposed to light and were watered. They were observed for pin heads formation leading to fruiting body production [12].

Data collection and analysis

The growth and development of mushroom were monitored daily. Growth parameters including stipe length (cm), stipe diameter (cm), pileus diameter (cm), and pileus thickness (cm) were recorded before each harvest. During harvesting, yield parameters, such as number of fruiting bodies, number of flushes and weight of fruiting bodies were collected. Two rounds of mushroom harvests were made across all substrate types in the course of the experiment; to examine the growth and yield performance of mushroom on the corncobs and sawdust substrates. The yield and biological efficiency were calculated. Accordingly, Biological Efficiency (B.E) was calculated as the percentage of yield of fresh mushrooms in relation to the dry weight of the substrate as given by Chang and Miles [13].

The analysis for moisture, ash, protein, carbohydrate, fat and dietary fiber of mushrooms from each substrate was determined using the method as described by AOAC Method [14].

Statistical analysis

Data collected from the study were subjected to analysis of variance (ANOVA), and significant means were separated using Fischer's least significant difference (analyzed using SAS 9.2 statistical package and Microsoft Excel at $p< 0.05$).

Plate 1: Spawn of *P. ostreatus*

Plate 2: Matured fruiting bodies of *P. ostreatus* cultivated on corncobs

Plate 3: Matured fruiting bodies of *P. ostreatus* cultivated on sawdust

Results and Discussion

The different substrates used for the cultivation of *Pleurotus florida* significantly supported its growth and yield at different levels. It was observed from Fig. 1 that higher mushroom stipe length with 2.95 cm and stipe diameter with 4.83 cm was harvested from corncob substrate compared with sawdust with stipe length of 2.23 cm and stipe diameter of 4.06 cm and they were statistically different from each other at P<0.05. Also higher pileus diameter of 4.53 cm was obtained on sawdust compared to that of corncob with 4.43 cm and pileus thickness with 1.07 cm of corncob was higher than that of sawdust with 0.92 cm. However there was no significant difference in the pileus diameter and pileus thickness of corncob and sawdust.
The results of the yield parameters of *P. florida* as shown in Fig. 2 revealed that weight of fruiting bodies harvested from corncob substrate with an average weight of 24.6 g was significantly higher than the one harvested on sawdust substrate with 15.5 g at P<0.05. And there was no significant difference for the number fruiting bodies and number of flushes of mushroom harvested from corncob and sawdust substrates.

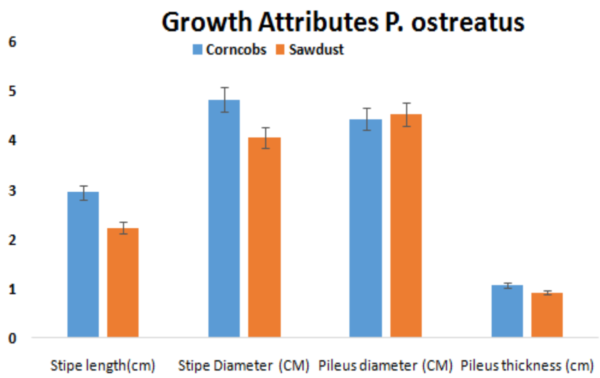
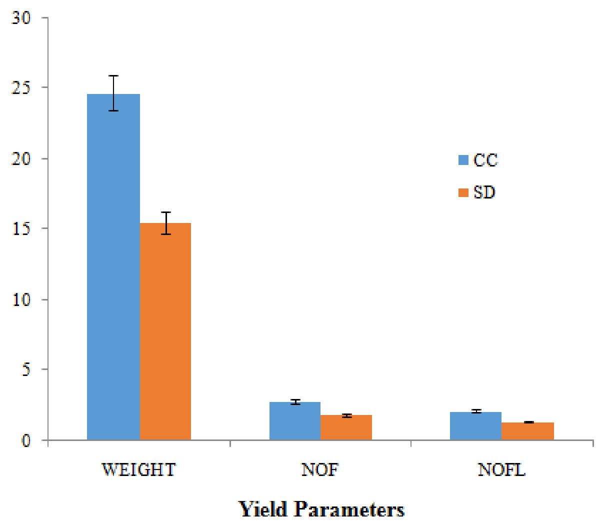


Figure 1: Growth attributes *P. ostreatus* cultivated on agro-waste



Weight: Weight (g); **NOF:** Number of fruiting bodies; **NOFL:** Number of flushes

Figure 2: Effect of corncob and sawdust substrates on the yield performance of *P. florida*

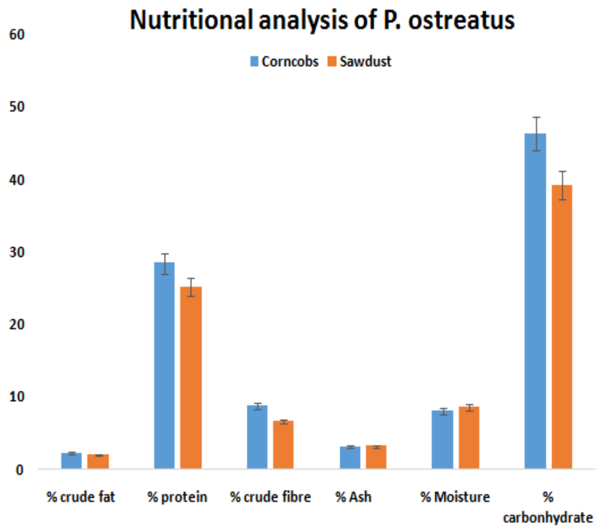


Figure 3: Nutritional analysis of *P. ostreatus* cultivated on agro-waste

The results of the proximate analyses of the mushroom cultivated on corncob and sawdust substrate is shown in Fig. 3 Mushroom cultivated on corncob was highly significant with 2.22% crude fat, 28.40% protein, 8.69% crude fibre and 46.33% carbohydrate content while sawdust was the least with 1.96, 25.10, 6.54 and 39.20%, respectively. Although, 3.12% Ash content and 8.50% moisture content obtained from sawdust substrate were the highest, they were not significantly different from that of corncob with 4.53% Ash content and 0.92% moisture content.
In this study, fresh weight of fruiting bodies of mushroom cultivated on corn cob substrate had the highest average fresh weight and was significantly higher compared to fresh weight obtained on the sawdust. This could be as a result of the differences that exist in the content of the substrates. This supports the work of Viziteu [15] who observed better performance in the weight of fruiting bodies of mushroom from corn cob over sawdust because the corncob has higher assimilable nitrogen, cellulose and hemicelluloses for corn cob as against sawdust. Maria *et al.* have reported that corncob has nitrogen content of 0.5% which is higher than that of sawdust derived from trees [16].
This study also showed that there were no significant difference in the number of fruiting bodies and flushes produced from both corncob and sawdust substrate which is in contrast with Onuha, who worked on mushroom cultivation on different substrates and observed that the mushrooms grown on sawdust produced the least number of fruiting bodies compared to those on corncobs [17]. This variation in results compared with the present study could be due to differences in wood types [18].
There was a significant difference in the mushroom stipe length and stipe diameter of *P. florida* grown on the different substrates. The mushroom with the highest stipe length and stipe diameter was harvested from corncob substrate. Our result was different compared to

previous study by Quimio *et al.*, who reported 100% sawdust showed the longest stipe (19.45 cm) [19].

Mushroom size depends on the types of substrates used. Cellulosic, hemicellulosic, and lignin materials could be a physical barrier that led to the difficulty in breaking them down without lignin-degrading enzymes. Elsisura *et al.* who explain different stipe lengths obtained from the current and previous studies [20].

The results of the proximate analyses of the mushroom cultivated on corncob and sawdust indicated that the ash and moisture content was higher in mushroom cultivated on sawdust substrate. This result was due to the water holding capacity of substrate. The lowest moisture content recorded from corncob substrate might be the poor nature of this substrate in water holding capacity as compared to other substrate. This result was similar to the report of Bhattacharjya *et al.* when *P. ostreatus* was cultivated on Sawdust [21]. The report of Hoa *et al.* confirmed high moisture content *P. ostreatus* cultivated on corncob and sawdust [22].

The findings revealed that mushrooms cultivated on corncob substrate had higher crude fat, protein and crude fibre. This result is in line with the study conducted by Noor *et al.* who reported that oyster mushrooms grown on sawdust and other substrates were rich in carbohydrates, fiber, protein, and energy but had very low-fat content, making them excellent for healthy and low-calorie diets [23].

Conclusion

The study has revealed that corncob used as a substrate for oyster mushroom cultivation performs better than sawdust in terms of yield and nutritional value. Therefore, corncob could be exploited as alternative substrate to wood sawdust for more sustainable production of mushroom. Since the sawdust supply will reach a limit, as forest protection has become a global issue.

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