Journal of Research in Forestry, Wildlife & Environment Vol. 12(3) September, 2020
E-mail: jrfwe2019@gmail.com; jfewr@yahoo.com
http://www.ajol.info/index.php/jrfwe
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ISBN: 2141 – 1778
Oladipo et al., 2020

COMPARATIVE YIELD AND BIOLOGICAL EFFICIENCY OF OYSTER MUSHROOM (*Pleurotus ostreatus*) CULTIVATED ON SAWDUST OF SOME SELECTED TREE SPECIES

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ABSTRACT

The performance of mushrooms in cultivation to a large extent depends on the substrates employed. Wood species were used as substrates. The study aimed to ascertain the potentials of producing edible macro fungi (Pleurotus ostreatus) cultivated using different substrates. The substrate treatments were Triplochiton scleroxylon, Ceiba pentandra and Cordia milleni, replicated five times and the samples were inoculated with mushroom seed (spawn) of Pleurotus ostreatus. The mycelia growth (%), lengths of stipe (cm), diameters of pileus (cm) and heights of flushes (cm) were recorded. Data recorded were subjected to Analysis of Variance and descriptive statistics. The analysis of variance carried out on yield and biological efficiency showed significant difference ($P \leq 0.05$). From the study, the result of biological efficiency shows that, T. scleroxylon gave a significantly higher mean of (72.64%) when compared with what was obtained using C. pentandra (49.84%) and C. millenii (57.34%) as substrate.

Keywords: Agricultural wastes, biological efficiency, comparative, *P. ostreatus*, yield

INTRODUCTION

The genus *Pleurotus* is a group of mushrooms with high nutritional values and therapeutic benefits (Corręa *et al.*, 2016). In tropical and subtropical rainforests, *Pleurotus* species are naturally found in favourable conditions which support their growth. These groups of mushrooms have also been observed to thrive well when artificially cultivated using a variety of agricultural wastes (Chang and Miles, 2004; Chirinang and Intarapichet, 2009). The cultivation of *Pleurotus* spp. has been observed and reported to possess efficient colonisation and bioconversion of ligno-cellulosic agro-industrial residues and other complex organic compounds, reducing the problem of waste disposal and creating a safe environment (Sanchez, 2010). Edible mushrooms are prepared and consumed by man in the form of soup, tablets, tea, capsules and extracts to complement food diets with various bioactive ingredients such as lectin, polysaccarides and other terpenoids which are deficient in foods of plant and animal origin (Rai *et al.*, 2005; Lee *et al.*, 2012).

The ability of edible mushroom to utilize different wastes plays a key role in the decomposition of organic substances, formation of simple organic byproducts and enrichment of soil microbes leading to soil fertility (Heilmann-Clausen and Boddy, 2005; Pavlík and Pavlík, 2013). Hence, the degrading enzymes in mycelia of *Pleurotus* spp. enable them to store some metabolic products such as polysaccharides, sterols, triterpenes and phenolic compounds.

Nigeria is richly endowed with good quality mushroom like *Pleurotus* species and *Agaricus* species (Onuoha, 2007). However, the cultivation of these mushrooms is still at low ebb while the technology of mushroom production and its adoption is still at research stage (Arowosoge *et al.*, 2017). The wood waste generated by the Nigerian sawmill which is usually burnt in the open air or dumped in large heaps to decompose has continued to increase with increasing number of operating sawmills, thus leading to environmental pollution (FAO, 1996). The utilization of these wastes for commercial production of mushrooms will make it available at a cheaper price throughout the year while preventing environmental pollution. Therefore, this present study examined the yield and biological efficiency of oyster mushroom (*Pleurotus ostreatus*) cultivated on sawdust of different tree species.

MATERIALS AND METHODS

Spawn preparation

Spawn were prepared in jam bottles. Sorghum grains were soaked in cold water for 24 hours and drained of excess water. The sorghum grains were boiled for 15 min and filled in 250 g jam bottles and sterilized in an autoclave at 121° C for 15 min. After sterilization, the bottles with sorghum grains were inoculated with actively growing mycelia of *P. ostreatus* from the slant and incubated at 28 ± 2^0 C for mycelia growth in the dark room until the bottle were fully ramified (Nurudeen *et al*., 2013).

Substrates preparation

Sawdust of *T. scleroxylon*, *C.* ***pentandra*** and *C. milleni* were collected from sawmill and used for the experiment. Fresh sawdust was mixed with 5% wheat offal and 1% lime ($CaCO_3$) to improve the growth of mushroom and water was mixed to moisten the substrates.

Polythene bags of 15 x 35 cm were filled with substrates weight of 400 g and pasteurized at 70-80 ^oC for 3 hours. After pasteurization, the substrates bags were allowed to cool. Thereafter the substrates bags were inoculated with spawn (mushroom seeds). After inoculation, the bags were kept under a controlled temperature (25 °C) and humidity (80-90%) with sufficient ventilation for 3-4weeks. The spawn run was completed within 25 days and polythene bags were torn-off at the tips following the spawn run. Development of fruit bodies was evident within 4-5days after opening the polythene. The bags were sustained up to the harvest of the fourth flush and it was completed within 37 – 42 days after spawning.

Plate 1: Preparation of Substrate

Plate 2: Ramifying substrate bags in incubation room

Plate 3: Matured *P. ostreatus*

Yield (Y) and Biological efficiency (BE)

Parameters such as length of stipe (cm), height, diameter of Pileus (cm) and total weight (g) of the fruiting bodies harvested from all the five picking were measured as total yield of the mushroom. The biological efficiency was subsequently calculated according to the following formula (Chang *et al*., 1981).

Biological efficiency (BE) % =
$$\frac{\text{Fresh weight of mushroom}}{\text{Dry weight sbstrate}} \times 100$$

Data analysis: The data obtained in the study were analyzed using analysis of variance, and descriptive statistics with the aid of statistical packages for social sciences (SPSS) version 16.

RESULTS

The effect of different sawdust type on the yield and biological efficiency of *P. ostreatus* was investigated in this study. Table 1 below shows the mean mycelia growth from different sawdust used. It was observed that *T. scleroxylon* had the highest mycelia growth within the first three weeks with mean aggregate of 83.12% followed by *C. pentandra* 74.18% and *C. millenii* 70.77% respectively. All the substrate attained the full ramification stage (100%) at the fourth week.

Table 1: Effect of different substrate on mycelia growth

substrate	Week 1	Week 2	Week 3	Week 4
Triplochiton scleroxylon	32.24 ± 1.94a	57.36 ± 0.98a	83.12 ± 1.29a	100.0 ± 0.00a
*Ceiba **pentandra***	27.46 ± 0.63b	46.90 ± 0.78b	74.12 ± 1.08b	100.0 ± 0.00a
Cordia milleni	21.28 ± 0.79c	45.18 ± 0.94c	70.94 ± 1.55c	100.0 ± 0.00a

Mean with the same alphabet are not significantly different

The variation in the length of stipe at different flushes was observed in the three species of sawdust, with the highest (6.6cm) observed in *T. scleroxylon* at the fourth flush. Though, the growth of mushroom from *Ceiba pentandra* and *Cordia millenii* were unable to reach the fourth flush like the mushroom cultivated on *T. scleroxylon*. A mean length of 6.5cm was observed in *P.ostreatus* cultivated on *T. scleroxylon* during the second flush followed by 6.4cm which was observed in *P.ostreatus* cultivated on *T. scleroxylon* and *C. pentandra* at flushes 1 and 3 respectively. The lowest was seen in *P.ostreatus* cultivated on *C. millenii* (5.7cm) in the first and third flushes. Consequently, the mean length of stipe in *P.ostreatus* cultivated on *T. sleroxylon*, *C. pentandra* and *C.millenii* ranges from; 6.2-6.6cm, 6.2-6.4cm and 5.7-6.2cm respectively (Table 2).

Table 2: Effect of different substrate on length of stipe (cm) per flush

Substrate	Flush 1	Flush 2	Flush 3	Flush 4
Triplochiton scleroxylon	6.40 ± 0.16a	6.50 ± 0.16a	6.20 ± 0.16a	6.60 ± 0.21a
Ceiba pentandra	6.20 ± 0.12a	6.40 ± 0.23a	6.30 ± 0.16a	0.00 ± 0.00b
Cordia milleni	5.70 ± 0.12b	6.24 ± 0.15a	5.78 ± 0.19b	0.00 ± 0.00b

Mean with the same alphabet are not significantly different

Difference in diameter of pileus at each flush exhibited by *P.ostreatus* cultivated on three sawdust of different tree species used in this study was presented in Table 3. While it varies from 5.9-7.2cm in *P.ostreatus* cultivated on *T. scleroxylon*, the same was between 6.0-6.2cm in *P.ostreatus* cultivated on *C. pentandra* with mushroom from *C. millenii* having a pileus diameter ranging from 5.8-6.2cm.

Table 3: Effect of different substrate on diameter of pileus (cm) per flush

Substrate	Flush 1	Flush 2	Flush 3	Flush 4
Triplochiton scleroxylon	6.50 ± 0.31a	6.10 ± 0.42a	5.90 ± 0.21a	7.20 ± 0.52a
Ceiba pentandra	6.10 ± 0.42a	6.20 ± 0.25a	6.90 ± 0.75a	0.00 ± 0.00b
Cordia milleni	6.20 ± 0.39a	6.20 ± 0.49a	5.80 ± 0.29a	0.00 ± 0.00b

Mean with the same alphabet are not significantly different

The mean mushroom height shows that *P.ostreatus* cultivated on *Triplochiton scleroxylon* has a higher length which ranges from 7.30-9.40cm at the fourth flush this is closely followed by *P.ostreatus* cultivated on *Ceiba petendra* with the range of 7.20-8.20cm. While *P.ostreatus cultivated on Cordia milleni* has the lowest height with range between 7.10-7.54.

Table 4: Effect of different substrate on mushroom height (cm) per flush

substrate	Flush 1	Flush 2	Flush 3	Flush 4
Triplochiton scleroxylon	7.30 ± 1.27a	9.10 ± 0.37a	8.70 ± 0.59a	9.40 ± 0.53a
Ceiba petendra	7.20 ± 0.47a	8.20 ± 0.69b	8.00 ± 0.75b	0.00 ± 0.00b
Cordia milleni	7.10 ± 0.85a	7.20 ± 0.47c	7.54 ± 0.51b	0.00 ± 0.00b

Mean with the same alphabet are not significantly different

The analysis of variance conducted for mushroom yield (g) and biological efficiency (%) showed significant difference ($P \leq 0.05$) across three wood species used. The follow up procedure using Duncan multiple range test showed that *Triplochiton scleroxylon* had the highest yield (Table 5&6) followed by *Ceiba pentandra* and *Cordia millenii* with mean yield values of 80.24±4.76, 74.12±3.27 and 64.85±1.56 respectively.

Table 5: The DMRT values for the yield (Y) (g) of the fruiting body of *P. ostreatus* in different substrates

Substrate	Mean	±Standard error	Duncan rating
Triplochiton scleroxylon	80.24	4.76	a
Ceiba pentandra	74.12	3.27	b
Cordia millenii	64.85	1.56	c

Mean with the same alphabet are not significantly different

The biological efficiency (%) exhibited by different wood wastes for the growth of *P. ostreatus*, showed that *Triplochiton scleroxylon* had the highest B.E followed by *Cordia millenii* and *Ceiba pentandra* with values of 72.64±1.26, 57.34±2.84 and 49.84±2.56, respectively.

Table 6: The DMRT values for the biological efficiency (BE) (%) as exhibited by different substrate

Substrate	Mean	±Standard error	Duncan rating
Triplochiton scleroxylon	72.64	1.26	a
Ceiba pentandra	49.84	2.56	b
Cordia millenii	57.34	2.84	c

Mean with the same alphabet are not significantly different

DISCUSSION

All substrates used in this experiment attained full ramification (100%). This result is in agreement with the findings of Ekpo *et al.* (2008) and Olasupo *et al.*, (2017) that *Pleurotus sajor-caju* increase in mycelia growth up to 100% regardless of the substrate composition. This is also related to findings of Chang *et al* (1991) in their study to identify suitable and efficient substrates for the production of *Pleurotus ostreatus* mushrooms where sawdust had the highest mycelia growth than other substrate employed.

It was observed that the flushes produced by each substrate were not the same; some bags were able to produce at least four flushes while others were only able to produce three flushes. Table 2, 3 and 4 shows the mean length of stipe, mean diameter of pileus and mean height of mushroom. *T. scleroxylon* had the highest mean length of stipe, mean pileus diameter and mean height of harvested mushroom. *C. pentandra* and *C. millenii* were unable to yield at the fourth flush thus stop at third flushes. The data recorded for mushroom yield from the three substrates are comparatively high. This suggested that all three substrate supported the yield of the *P. ostreatus* and this is in agreement with the findings of Muhammad *et al.*, (2005), where they clarified that Oyster mushroom gave the maximum flushes on sawdust substrate.

Result showed that mushroom yield is reliant on biological efficiency as overall biological efficiency determines the mushroom yield which is in accordance with the findings of Nurudeen *et al.*, (2012) and Olasupo *et al.*, (2017) that mushroom yield is dependent on biological efficiency. Nonetheless, mushroom cultivated on *C. pentandra* and *C. millenii* could not maximize the nutrient available thus resulted into comparatively lower yields and biological efficiencies. This finding is in accordance with the findings of Familoni *et al.*, (2018) where it was observed that the BEs of cultivated mushrooms always vary between fungal species, type or size of substrate used, supplement used and other varying growth factors. Hoa *et al.*, (2015) related the inconsistency of BE to the differences in the physical and chemical compositions of the substrate, which include cellulose/lignin ratio, mineral contents, pH, electrolyte conductivity (EC) of the substrate and ratio of carbon to nitrogen (C:N).

CONCLUSION

The effect of different sawdust types on the yield and biological efficiency of oyster mushroom (*P. ostreatus*) was established in this study. Consequently, the overall length of stipe, diameter of pileus and mushroom height obtained was an indication that the mushrooms attained a good sizable stage. Furthermore, the relationship between biological efficiency and mushroom yield is an indication that biological efficiency is a function of mushroom yield. The overall performance of the selected sawdust of different tree species (*Triplochiton scleroxylon, Ceiba pentandra and Cordia millenii*) showed that all the wood wastes supported the sporophore emergence and thus resulted in mushroom yield in varying levels.

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