GROWTH AND YIELD RESPONSES OF *Pleurotus ostreatus* (Jacq. Ex Fr. P.Kumm) CULTIVATED ON SELECTED WOOD RESIDUES

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Abstract
The study evaluated the growth, yield and the antioxidant potentials of Pleurotus ostreatus grown on the wood residues of Tectona grandis, Albizia zygia, Swietenia macrophylla and Terminalia superba. Complete Randomize Design (CRD) method was adopted and replicated 7 times, data collection was initiated one week after inoculation and was done every week for a period of four weeks. Parameters measured include mycelia growth, height, weight, tips (Diameter of pileus) and the phytochemical composition of the mushroom. Analysis of Variance (ANOVA) was used to test the data collected. Least Significant Design (LSD) at 5% level of probability was used to separate means. The result indicated that the mycelia growths were completed within four weeks, Terminalia superba recorded the highest for the mycelia growth, total phenolic, saponin, alkaloid and lowest in flavonoid while Albizia zygia substrates recorded the highest mean value for diameter of pileus, total mushroom yield, flavonoid, tanning and lowest in total phenolic. Tectona grandis recorded highest height, least in saponin and alkaloid while Swietenia macrophylla recorded least tannin. The wood residue of Terminalia superba and A. zygia recorded the best among the four treatments. Using A. zygia and T. superba as substrates in cultivation of mushroom supports maxima growth and yield.

Keywords: *Antioxidant potentials, Growth, Pleurotus ostreatus, Wood residues, Yield*

Introduction

Mushrooms are the fruiting body of macro fungi (i.e. *Basidiomycota*). The life cycle of mushrooms can range between 1-2 days and up to many years, the mycelial network of fungal species can exist for up to hundreds or thousands of years. Maria *et al*., (2015) documented that mushrooms have been consumed since earliest history, ancient Greeks believed that they provided strength for warriors in battle, and the Romans perceived them as the food of the gods.

Mushrooms are reliable source of nutriments and their protein is between the well known animals and vegetables (Girma and Tasisa., 2020). Mushrooms have played crucial parts as human cuisine due to their nutritional and medicinal properties. Several species of oyster mushroom can be grown on lignocelluloses, plants and agricultural wastes (Biswas and Biswas, 2015).

Based on their chemical composition and benefits, mushroom can be classified as poisonous and edible, where edible mushroom can also be categorized into those collected from the wild and the already cultivated edible mushrooms. Krishnamoorthy (2014) added that mushrooms epitomise an essential parts of human nourishment, and recently the amounts of feeding have escalated due to it high nutritional value, market expansion, changing of consumer's behavior and development. Dipan *et al.*, (2018) reported that mushrooms are expressed as essential nutriment, which can provide care insurance beyond the traditional nutrients they contain. Oyster mushrooms are one kind of edible saprophytic fungi growing on dead organic matters of vegetative origin belonging to the genus *Pleurotus* under the class Basidiomycetes (Grabarczyk, *et al.*, 2019). Oyster mushrooms can be grown on various wood residues with the use of different technologies. They are appetizing with fan shaped pileus which is essential source of small and large nutrients. Oyster mushroom has no starch, low sugar content and high amount of fiber, hence it serves as the least fattening food (Girma and Tasisa., 2020). Oyster mushrooms is nutritious with fat (2-5%), minerals (potassium, phosphorus, calcium, sodium) of about 8-12%, mycocellulose (7-38%), sugars (17-47%) and dried protein (25-50%). Recently, its significance has been realized and well utilized in human diet, livelihoods can be refined because the request for mushroom has escalated due to population increase, booming market and changing of consumer attitudes (Celik and Pekker, 2009).

Finimundy *et al.*, (2013) reported that more than 100 medicinal functions and uses are attributed to mushrooms including; antioxidant, anticancer, antidiabetic, anti-allergic, immune modulating, cardiovascular protector, anti-parasitic, antifungal, have detoxification, and hepatoprotective effects. Adebayo and Oloke, (2017) added that they also hinders tumor development and inflammatory processes in humans.

There are numerous species of *Pleurotus* recognized and are suitable for cultivation, some of them are *P. ostreatus, P. florida P. sajor-caju, P. eryngii* (Nadir *et al.*, 2016). However, *Pleurotus ostreatus* is the most cultivated species being easier to culture, favorable thrive on diverse agriculture by-products i.e. rice straw, sawdust, wheat straw, corn silk, sugarcane bagasse and other plant fibers having cellulose content (Ju, 1994; Kong, 2004). Substrates having elevated nitrogen and carbohydrate contents are rated as perfect for mushroom growth (Khare *et al., 2010*). Hence, this study is to determine the growth and yield responses of *Pleurotus ostreatus* on four different wood residues and to determine the antioxidant potentials of *Pleurotus ostreatus* on the four different wood residues.

Materials and methods

The experiment was executed at the Mushroom Unit laboratory of Pathology Section, Forest Conservation and Protection Department, Forestry Research Institute of Nigeria, Ibadan. The Institute is situated in Jericho hill, Ibadan North West Local Government Area of Oyo State. The area lies between latitude 7°26'N and longitude of 3°54'E. The climatic condition of the area is tropically dominated by rainfall pattern from1400mm-1500mm. The average temperature is about 30°C, average relative humidity of about 80-85% (FRIN, 2019).

Materials used

Wood residues (Saw-dust) from four (4) forest trees namely: *Tectona grandis, Albizia zygia, Swietenia macrophylla, Terminalia superba*, Wheat bran, Water, Mushroom seed, White polythene nylon, Rubber band, 30 cm long ruler, Methylated spirit, Cotton wool, Weighting scale (sensitive), Vernier caliper, Bowl, Inoculating rod or spoon, Holestick and Hand Sprayer were used .

Sources of materials used

The wood residues were obtained at Sango and Apete sawmills, and the wheat bran was obtained at Pathology section. The spawn (Mushroom seed) were obtain at the Pathology section.

Substrate preparation

Mixing and bagging

The wood residues from the selected forest trees were mixed separately with 1% agricultural lime and 5% wheat bran to enhance growth of the mushrooms and bagged into transparent poly-ethylene bag (0.2mm) at 1kg per bag. The bags were thereafter tied with rubber bands and taken for pasteurization.

Pasteurization

Pasteurization was carried out immediately after bagging which was meant to remove harmful organisms that may impede the growth of the desired mushrooms. The substrate bags were pasteurized for four hours. Materials such as bowls and workbench for arranging the bags after pasteurization were sterilized with cotton wool dabbed with methylated spirit.

Inoculation

The pasteurized bags were untied and a hole bored in the middle of the bag using an inoculating rod to accommodate the spawn (mushroom seed). Thereafter, spawn was introduced at 2% of the fresh weight of the substrate.

Incubation

After introducing the spawn, the bags were tied back with rubber bands labeled and arranged accordingly.

Data collection

Data gathering commenced a week after inoculation and records were taken weekly. The following parameters were measured; mycelia growth, height, weight and diameter of pileus.

Mycelium growth was measured once a week with a 30 cm long transparent ruler. The length of the harvested mushroom and the diameter of pileus were measured with 30 cm long ruler and the diameters of the mushrooms were measured with vernier caliper. Sensitive weighing scale was used for weighing the harvested mushrooms.

Data analysis

Analysis of Variance (ANOVA) was used to test the data obtained, while Least Significant Design (LSD) at 5% level of probability was used to separate the means.

Phytochemical analysis of harvested mushrooms

Fresh mushrooms (Pileus + stipe) were rinsed thoroughly to get rid of extraneous materials and sun-dried on blotting paper by constant exposure to sunlight for 2 – 4 days while turning the mushrooms to avoid fungal growth (Johnsy *et al*., 2011). Then it was cut into pieces and later milled to obtain mushroom meals (MRMS) using mortar and pestle and was stored in a container until needed for analysis (Egwim *et al.,* 2011). The quantitative Screening (determination of tannin, determination of alkaloid, total phenolic content, test for saponin and total flavonoid content) of phytochemical compounds in *Pleurotus ostreatus* cultivated on the four wood residues were carried out after harvest.

Results and discussion

P. ostreatus mycelia growth on the four wood residues is recorded in Table 1, the result indicated that all the wood residues supported the mycelia growth and was completed within four weeks. *T. superba* recorded the fastest ramification rate (mycelia growth) after three weeks followed by *T. grandis.* At the end of four weeks, the least mean value was recorded in *A. zygia* (15.76cm)

Table 1: **Weekly mean mycelia growth on four different wood residues (cm)**

Mean treatment	week 1	Week 2	Week 3	Week 4
Tectona grandis	5.67	11.67	16.97	18.13
Albizia zygia	4.90	12.20	15.54	15.76
Swietenia macrophylla	5.54	11.24	16.23	16.56
Terminalia superba	5.58	13.84	18.56	19.04
LSD (P≤0.05)	0.57*	0.98**	1.68**	0.77**

Table 2 reported that the mushrooms grown on the four wood residues were not different significantly from each other in height, although the mushroom raised on *T. grandis* recorded the highest mean value of 7.47cm in height while the least mean value was recorded in *T. superba* with the values of 4.96cm.

Table 2: Mean mushroom height on four different wood residues

Treatment	Mean height (cm)
Tectona grandis	7.47
Albizia zygia	6.79
Swietenia macrophylla	6.90
Terminalia superba	4.96
LSD (P≤0.05)	2.60^{NS}

Table 3: Mean mushroom diameter of pileus on four different wood residues

Treatment	Mean diameter of pileus (cm)
Tectona grandis	5.66
Albizia zygia	6.46
Swietenia macrophylla	5.49
Terminalia superba	4.39
LSD(P≤0.05)	3.32^{NS}

Table 3 shows *P. ostreatus* diameter of pileus on different wood residues. The result indicated that *Albizia zygia* recorded highest diameter of pileus (6.46cm) while *T. superba* recorded the least diameter of pileus with the mean value of 4.39cm. There were no significant differences among the diameter of pileus from the four wood residues used.

Table 4: Mean mushroom stem diameter on four different wood residues

Treatment	Mean stem diameter (cm)
Tectona grandis	0.81
Albizia zygia	1.49
Swietenia macrophylla	0.72
Terminalia superba	0.83
LSD (P≤0.05)	0.41**

Table 4 shows *P. ostreatus* stem diameter on the four different wood residues. The result reported significant differences in the stem diameters of the mushrooms raised on the wood residues. *Albizia zygia* recorded the highest mean value of 1.49cm in stem diameter and significantly different from others. *S. macrophylla* recorded the least mean value of 0.72cm but was not significantly different from *T. superb* and *T. grandis* with mean values of 0.83cm and 0.81cm respectively.

Table 5: Mean mushroom Yield on four different wood residues (g)

Treatment	Mean yield
Tectona grandis	34.1
Albizia zygia	48.1
Swietenia macrophylla	20.7
Terminalia superba	34.9
LSD (P ≤ 0.05)	19.81^{NS}

Table 5 reports *P. ostreatus* yield on wood residues. *Albizia zygia* recorded highest mushroom yield of 48.1g followed by T. *superba*, and *T. grandis* with 34.9g and 34.1g mean values respectively. The least mean value was reported in *S. macrophylla* with 20.7g mean value. Although *A. zygia* recorded the highest yield, it wasn't different significantly from other three substrates.

Table 6: Quantitative phytochemical screening of *P. ostreatus* grown on four Indigenous wood residues

SAMPLE	TOTAL PHENOLIC Mg/g	FLAVONOID Mg/g	SAPONIN Mg/g	TANNIN Mg/g	ALKALOID Mg/g
Tectona grandis	0.2042	0.16	0.3063	0.5496	3.676
Albizia zygia	0.2017	0.18	0.7361	0.7487	8.8336
Swietenia macrophylla	0.2112	0.1467	0.5547	0.437	6.656
Terminalia superb	0.2138	0.13	0.9715	0.5832	11.6576

Table 6 shows *P. ostreatus* total phenolic, flavonoid, Saponin, Tannin and Alkaloid grown on wood residues The result showed that *T. superba* recorded highest total phenolic (0.2138mg/g), Saponin (0.9715mg/g), alkaloid (11.6576mg/g) and lowest flavonoid (0.13mg/g) respectively. *Albizia zygia* recorded highest flavonoid (0.18mg/g), tannin (0.7487mg/g) and lowest total phenolic (0.2015mg/g). *Tectona grandis* recorded least saponin (0.3063mg/g) and alkaloid (3.676mg/g) respectively. *Swietenia macrophylla* recorded least tannin (0.437mg/g) respectively. This upholds the report by Unekwu *et al*., (2014) that mushroom contain different compounds. The result also indicates that the chemical compounds in mushroom depend on the substrate used. With the presence of these compounds in mushroom, their consumption will help to remove toxins from the body as a result of their free radical scavenging activities and hence they help in making us healthy. Garcia-Lafuente *et al.*, (2011) also explained that mushrooms have been used in medically to manage simple and age-old epidemics like skin eruption and to prevent some compound and pandemic diseases such as AIDS.

Conclusion and recommendation

The wood residues of *T. superba* and *A. zygia* recorded the best among the four wood residues used for this experiment. Moreover, supplement such as lime ($caco_3$), wheat bran increase the pH of the water, causing the mold spores, bacteria, and other contaminants in the straw to be killed off thus enhancing the richness of the substrate which resulted into high yield of *P. ostreatus* on the wood resid*ues*. Furthermore, the use of wood residues as medium for mushroom cultivation will aid reducing environmental pollution as a result of high amount of lignocelluloses waste. Also protein intake can be improved and poverty eradicated when the cultivation of mushroom is encouraged among the populace. The antioxidant properties of mushrooms also depend greatly on the substrate used.

This study recommends the need for more research on different wood residues for mushroom cultivation to explore their suitability for mushroom cultivation.

References

Adebayo, E. A and Oloke, J. K. (2017). Oyster Mushroom (Pleurotus Species); A Natural Functional Food. *Journal of Microbiology, Biotechnology and Food Sciences*. 7(3): 254-264.

Adebayo, E. A., Oloke, J. K., Aina, D. A. and Bora, T. C. (2014b). Antioxidant and Nutritional Importance of some Pleurotus species. *Journal of Microbiology, Biotechnology and Food Sciences*. 3(4): 289-294.

Biswas, M. K. and Biswas, S. B. (2015). Recycling of ligno-cellulosic waste materials through Oyster mushroom cultivation for sustainable food production. Ecoscan 9:655–659

Celik, Y and Pekker, K. (2009). Benefit/Cost analysis of mushroom production for diversification of income in developing countries. *Bulgarian Journal of Agricultural Science* 15(3): 228-237.

Dipan, S., Ajay, K. S. and Badal, K. D. (2018). Bioactive compounds with special references to anticancer property of oyster mushroom *Pleurotus ostreatus. Journal of Pharmacognosy and Phytochemistry.* 7(4): 2694-2698.

Egwim, E. C., Elem, R. C. and Egwuche, R. U., (2011). Am. J. Food. Nutr, 2011, 1(2): 89-94

Finimundy, T., Gambato, C. and Fontana, R. (2013). Aqueous extracts of *Lentinula edodes* and *Pleurotus sajor-caju* exhibit high antioxidant capability and promising in vitro antitumor activity. Nutrition Research. 33(1): 76-84.

Forestry Research Institute of Nigeria (FRIN) (2019). Meterological Station Report. Garcia-Lafuente, A., Moro, C., Villares, A., Guillamón, E., Rostagno, M.A., D'Arrigo, M. and Martinez, J.A. (2011). Mushrooms as a source of anti-inflammatory agents. *American Journal of Community Psychology*. 48(1-2): 125-141.

Girma Waktola and Tasisa Temesgen(2020). Pharmacological activities of oyster mushroom (*Pleurotus ostreatus*). *Novel Research in microbiology journal*, 4(2): 688-695.

Grabarczyk, M., M ˛aczka, W., Wi ´nska, K., Ukla ´nska-Pusz, C (2019). Mushrooms of the Pleurotus genus–properties and application. Biotechnol. Food Sci. 2019, 83, 13–30.

Johnsy, G., Davidson S., Dinesh, M.G. and Kaviyarasan, V. (2011). Nutritive value of edible wild mushrooms collected from the Western Ghats of Kanyakumari District. Botany Res. Int. 4(4): 69-74.

Ju H. Y. (1994). Oyster mushroom cultivation. Department of Plant science, Nova Scotia Agricultural College. Canada. pp. 1-3.

Khare K. B, Mutuku J. M, Achwania O. S and Otaye D. O. (2010). Production of two oyster mushrooms, *Pleurotus sajor-caju* and *P. florida* on supplemented and un- supplemented substrates. International Journal of Agriculture and Applied Science, 6(04): 4-11.

Kong, W. (2004). Oyster Mushroom Cultivation (Descriptions of Commercially Important *Pleurotus species*). Mushroom Growing Handbook 1, Mushworld 54-61.

Krishnamoorthy, D. and Sankaran, M. (2014). *Pleurotus ostreatus*: an oyster mushroom with nutritional and medicinal properties. *Journal of Biochemical Technology*. 5(2): 718-726.

María, E.V., Talía, H. and Octavio, P. (2015).Edible Mushrooms: Improving Human Health and Promoting Quality Life. *International Journal of Microbiology*. 1-14.

Nadir, H. A., Ali, A. J. and Muhammed, G. A. (2016). Determination of Yield and Quality of Oyster Mushroom (*Pleurotus florida*) Using Different Substrates in Halabja, Kurdistan. Plant Production, 7: 787–790.

Okafor, D. C., Onuegbu, N. C., Odimegwu, N. E., Ibeabuchi, J. C., Njoku, N. E., Agunwa, I. M., Ofoedu, C.E. and Njoku, C.C. (2017). Antioxidant and Antimicrobial Activities of Oyster Mushroom. *American Journal of Food Science and Technology.* 5(2): 64-69.

Unekwu, H. R., Audu, J.A., Makun, M. H., and Chidi, E. E. (2014). Phytochemical screening and antioxidant activity of methanolic extract of selected wild edible Nigerian mushrooms. *Asian Pacific Journal Tropical. Dis.*, 4: S153-S157.