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Nutritional Composition of Oyster Mushroom (*Pleurotus ostreatus*) Grown on Softwood (*Daniella oliveri*) Sawdust and Hardwood (*Anogeissus leiocarpus*) Sawdust

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Authors' contributions

This work was carried out in collaboration between all authors. Author GFO designed the study and wrote the protocol. Authors SWS and IAA performed the laboratory experiment and the statistical analysis. Author OPB wrote the first draft of the manuscript and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was conducted to examine the effect of two different substrates (sawdust) obtained from hardwood (*Anogeissus leiocapus*) and softwood (*Daniellia oliveri*) on nutritional composition and yield of oyster mushroom (*Pleurotus ostreatus*). The proximate composition, mineral content and various growth parameters were analysed on the harvested mushroom from the two substrates. The proximate composition result showed that oyster mushroom harvested from the hardwood sawdust *(Anogeissus leiocapus)* have the highest protein content (26.67%), ash (9.83%) and crude fibre (11.05%). The mushroom harvested from the hardwood sawdust *(Anogeissus leiocapus)* also had the highest mineral content with potassium having the highest (22.81 mg / 100 g). The growth assessment of the mushroom harvested from the two substrates showed that softwood sawdust (*Daniellia oliveri*) has a better yield than hardwood sawdust. In conclusion, hardwood sawdust *(Anogeissus leiocapus)* produced oyster mushroom with better nutritional quality than softwood sawdust (*Daniellia oliveri*).

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Keywords: Oyster mushroom; sawdust; proximate composition; mineral content; substrate.

1. INTRODUCTION

Waste control is one of the major challenges in the world today. Various ways and methods have been developed in controlling waste from various sources, such as chemical, biological and plant waste [1]. Mushroom cultivation is one of the biotechnological processes for lignocellulosic organic waste recycling and uses [2]. Mushroom was rated second when compared to yeast cultivation in commercial microbial technology [3]. Mushroom has been eaten for various reasons, such as flavour, medicinal properties, ecological values and nutritional composition [4, 5] and [6]. The nutrients present in mushroom are rated as those of eggs, milk and meat [7], with essential amino acids and vitamins [5,8].

Agaricus bisporus, is the most cultivated mushroom in the world, followed by *Pleurotus spp* [9]. Cultivation of *Pleurotus ostreatus* has increased tremendously in the past few years because of its easy cultivation and nutritional composition. These are healthy foods, low in calories and in fat, and rich in protein, chitin, vitamins and minerals like other mushroom [10]. Oyster mushroom is good source of essential amino acids and non-essential amino acids such as gamma-amino butyric acid (GABA) and ornithine. Gamma-amino butyric acid is a non-essential amino acid that functions as a neurotransmitter whereas ornithine helps in synthesizing of arginine [11]. The report of Jayakumar et al. [12] showed that the hepatotoxicity induced by CCl_4 in rat was alleviated by the extract from *Pleurotus ostreatus.*

So many factors affect the nutritional composition, growth and yields of mushroom. They include difference strains, methods of cultivation, stage of harvesting, composition of growth substrates and environmental factors such temperature and relative humidity [13]. Cultivation of *Pleurotus ostreatus* help in managing organic waste whose disposal has become problem in many cases. Its' cultivation and consumption will help in providing solution to malnutrition problem in developing countries [14], and jobs for people. When the environmental conditions are good (temperature, relative humidity, luminosity), they produce lignocellulase enzymes (laccase and Manganaseperoxidase) which convert these lignocellulosic residue into food [15].

Many research works have been conducted to determine the nutritional composition and the yield of *Pleurotus ostreatus* grown on various substrates such as sawdust from *Daniella oliveri* tree [16], straw and rice hull [17]. Sawdust from soft wood has been reported to give the highest yield [18], However, further work is required to determine the nutritional composition, yield and mineral content of *Pleurotus ostreatus* grown on other substrate such as sawdust from hard wood. Hence, the study is aimed at comparing the yield, mineral composition and proximate composition of *Pleurotus ostreatus* grown of sawdust from both soft (*Daniella olivery* tree) and hard wood (*Anogeissus leiocapus* tree).

2. MATERIALS AND METHODOLOGY

2.1 Spawn Preparation

The spawn preparation was carried out by the method described by Ogundele et al. [16]. Sorghum, sterile bottles, cotton, aluminium foil, water and previous spawns were used in preparing the spawn. Light dirt and dust were removed by aspiration, and sorting was used to remove unwanted materials like stone, metals and broken grains. Sorted Sorghum was soaked in clean water over night after washing. The following day, it was re-washed, drained and steamed for 30-45 minutes. The steamed grain was drained and spread to cool in the open space. Three quarter of the sterile bottles were filled with sorghum and the bottles mouth plugged with cotton wool and wrapped with aluminium foil. Plugged bottles were sterilized in an autoclave at 121ºC for 15 minutes, and allowed to cool and inoculated with 1/10 of the previous spawn as inoculums. The inoculated bottles were incubated until the mycelium completely colonized the growth medium.

2.2 Substrate Preparation

Pure sawdust from soft wood (*Daniella olivery*) and the saw dust from the hard wood (*Anogeissus leiocapus*) were obtained from the saw-mill (lumber yard) within the town (Offa, Kwara State). These substrates were mixed with calcium carbonate, rice bran and water. All the component ingredients were mixed and water was added to make 65% moisture level of the mixture. The mixture was left for 45 minutes for water absorption and moisture uniformity within the substrate. The substrate was then filled into 500 g polypropylene bags (Size 7" X 10") and their mouths were plugged by inserting water absorbing cotton wool with the help of plastic neck and rubber band.

2.3 Pasteurization

The prepared substrate were autoclaved at 121ºC for 1 h in forced air oven (SLN 115, POL-EKO, Labex, South Africa), cooled, and inoculated with the matrice culture of *Pleurotus ostreatus* at the rate of 5 g per packet. The inoculated packets were incubated at 25ºC in culture room. During spawn multiplication the temperature of growth room was controlled between 24-26ºC. Water was sprinkled on the floor of incubation chamber several times a day so as to maintain the humidity to about 70-80%.

2.4 Samples Preparation

Pleurotus ostreatus fruits were dried at 40ºC in forced air oven (SLN 115, POL-EKO, Labex, South Africa), then milled into powder and packaged inside polyethylene bag and stored at room temperature for further analysis.

2.5 Proximate Analysis

Association of Official Analytical Chemists [19] methods were used in determining the moisture content (925.10), protein (920.87), crude fat (920.85), crude fibre (920.86) and ash (923.03) of two separate flushes. The carbohydrate content was determined by subtraction of other proximate value from 100%.

2.6 Mineral Content Determination

Minerals content (Calcium, Sodium, Magnesium, Phosphorus, Potassium, and Zinc) of the *Pleurotus ostreatus* were determined on two separate flushes harvested using AOAC [19] method 984.27. The dried samples were digested with a mixture of concentrated nitric acid, sulphuric acid and perchloric acid (10:0:5:2, v/v) using an atomic absorption spectrophotometer (GBC 904AA; Germany). The total phosphorus was determined as orthophosphate by the ascorbic acid method after acid digestion and neutralization using phenolphthalein indicator and combined reagent [20]. The absorbance was read at 880 nm (Spectronic 21 D, Miltonroy, NY, USA) and KH_2PO_4 (Merck, India Limited, Mumbai, India) served as the standard.

2.7 Statistical Analysis

Obtained data were statistically analysed by using Statistical package for Social Science (IBM SPSS) for windows, version 20. Results were analysed using one-ways analysis of variance (ANOVA). Differences among means were tested by the Duncan's test. Significance level was defined using $P \leq 0.05$.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

Table 1 showed the proximate composition results of *Pleurotus ostreatus* grown on two different substrates. The moisture content of the mushroom (*Pleurotus ostreatus)* harvested from hardwood sawdust (*Anogeissus leiocarpus*) was higher (8.93% db) than that harvested from softwood sawdust (*Daniellia oliveri*) (7.88% db). The protein content of the mushroom harvested from the hardwood sawdust (*Anogeissus leiocarpus*) was higher (26.67% db) than that harvested from (*Daniellia oliveri*) sawdust (17.68% db). There was no significant difference at $p < 0.05$ in values of ash content of mushroom harvested from the substrates. The crude fibre content of the mushroom harvested from hardwood sawdust (*Anogeissus leiocarpus*) were higher in value (9.59% db) when compared to mushroom grown and harvested from softwood sawdust (*Daniellia oliveri*) (10.66% db). The crude fat and carbohydrate content of mushroom from hardwood sawdust (*Anogeissus leiocarpus*) were lower (1.72 and 41.57% db) when compare to that mushroom harvested from softwood sawdust (*Daniellia oliveri*) (1.81 and 52.04% db).

The variation in proximate composition of the *Pleurotus ostreatus* grown and harvested from the two substrates may be attributed to the nutritional composition of the substrate where these were cultivated. Oyetayo and Ariyo [21] reported that the substrate on which mushrooms is cultivated have effect on the nutritional composition of such mushroom. The increase in the moisture content of the *Pleurotus ostreatus* grown on hardwood sawdust (*Anogeissus leiocarpus*) may be due to accessibility of the water present in the sawdust and limited accessibility of the same water in softwood sawdust (*Daniellia oliveri*). Although the substrates were watered to keep the substrate water content constant for better fruiting. It can also be attributed to the degrading ability of ligninolytic peroxidase enzyme produced by the mushroom root to help in decomposing the sawdust for the accessibility of the nutrient present [15]. The same reason may be the cause of the increase observed in protein content of *Pleurotus ostreatus* harvested from hardwood sawdust (*Anogeissus leiocarpus*) (26.67% db), ash content (9.83% db) and crude fibre (11.05% db). The finding was in line with the report of Patil et al. [22] that increase in protein content discovered in mushrooms may be attributed to decomposition of total carbohydrate, cellulose, hemicellulose and fibre during growth stage.

The proximate composition of the samples analysed in this study were higher than the values reported by Ogundele et al. [16] on *Pleurotus ostreatus* grown on pure substrate (*Daniellia oliveri* sawdust) and mixed substrate (*Daniellia oliveri* sawdust and that of *Mulainaner* wood sawdust).

3.2 Mineral Content

The mineral contents of *Pleurotus ostreatus* harvested from the two substrates used (Hardwood and softwood sawdust) are shown in Table 2. Calcium, sodium, potassium, phosphorus, magnesium and zinc were analysed. In this study, potassium have the highest value (22.81 mg/100 g and 21.90 mg/100 g), followed by phosphorus (10.36 and 10.09 mg/100 g), calcium (3.51 and 3.42 mg/100 g), and sodium (3.51 and 3.00 mg/100 g) for mushroom harvested from hardwood (*Anogeissus leiocarpus*) sawdust and softwood (*Daniellia oliveri*) sawdust respectively. This result was similar to the report of Alananbeh et al. [23]; reported highest value for potassium obtained from *Pleurotus ostreatus* harvested from four different substrates. Potassium was reported to be essential for several enzymatic reactions in food [24], and the quantity in *Pleurotus ostreatus* makes it good food for people suffering from hypertension and heart diseases [23].

The least mineral values were recorded from Magnesium and Zinc. About 1.25 mg/100g of Magnesium was obtained from the *Pleurotus ostreatus* harvested from hardwood (*Anogeissus leiocarpus*) sawdust while 1.04 mg/100g was obtained from softwood (*Daniellia oliveri*) sawdust. *Pleurotus ostreatus* harvested from hardwood (*Anogeissus leiocarpus*) sawdust recorded 0.96 mg/100 g of zinc and 0.95 mg/100 g from that of softwood (*Daniellia oliveri*) sawdust. All the values obtained from the *Pleurotus ostreatus* harvested from the two substrates show no significant difference at p≤ 0.05. This may be due to similar value for ash content obtained from the mushrooms harvested. The ash left behind after complete incineration of the dry mushroom and other food materials represents the minerals [25]. The values obtained in this study were higher than the values reported by Gbolagade [26], and Dundar et al. [27] for *P. tuber-regium*, *P. florida* and *P. sajor-caju*. The mineral values obtained in this study are adequate to maintain good health, since some of these minerals play important roles in glucose maintenance and the release of insulin from betal cell of islets of langerhan Kar et al. [28] and Agomuo [29].

Table 1. Proximate composition of mushroom (*P. ostreatus*) harvested from two different substrates (%) in dry basis

Substrate	Moisture content	Protein	Ash	Crude fat	Crude fibre	Carbohydrate
Softwood sawdust	7.88^{a}±0.11	17.68^{a}±0.32	9.59^{a}±0.12	1.81^{b}±0.20	10.66^{a}±0.14	52.04^{b}±0.46
Hardwood sawdust	8.93^{b}±0.21	26.67^{b}±0.18	9.83^{a}±0.12	1.72^{a}±0.11	11.05^{b}±0.30	41.57^{a}±0.60

Means within the same column of each oyster mushroom followed by the same letters are not significantly different at p ≤ 0.05 according to Duncan's multiple range tests

Table 2. Mineral composition of *P. ostreatus* harvested from the two substrates (mg/100 g) in dry basis

Substrate	Ca	Na	K	P	Mg	Zn
Softwood sawdust	3.42^{a}±0.2	3.00^{a}±0.1	21.90^{a}±0.3	10.09^{a}±0.1	1.04^{a}±0.1	0.95^{a}±0.2
Hardwood sawdust	3.51^{a}±0.2	3.51^{b}±0.1	22.81^{a}±0.5	10.36^{a}±0.2	1.25^{b}±0.1	0.96^{a}±0.2

Means within the same column of each oyster mushroom followed by the same letters are not significantly different at p ≤ 0.05 according to Duncan's multiple range tests

Table 3. Assessment of growth Parameters of *P. ostreatus* on the two substrates for both first and second flush

Substrate	Pin head (mm)	Height (mm)	Diameter (m)	Fruiting bodies/ bunch	No of well formed/ bunch	No of deformed/ bunch	Yield (g/bunch)
Softwood sawdust	$62.30^{b}\pm0.1$	$12.48^{b}\pm0.1$	$17.63^{a}\pm0.2$	$42.52^{b}\pm0.1$	$29.63^{b}\pm0.2$	$16.37^{b}\pm0.2$	$208.87^{b}\pm0.1$
Hardwood sawdust	$29.78^{a}\pm0.2$	$11.29^{a}\pm0.1$	$24.02^{b}\pm0.2$	$22.50^{a}\pm0.3$	$14.55^{a}\pm0.1$	$7.61^{a}\pm0.2$	$101.37^{a}\pm0.1$

Means within the same column of each oyster mushroom followed by the same letters are not significantly different at p ≤ 0.05 according to Duncan's multiple range tests.
All the results were average of two flushes harvested

3.3 Assessment of Growth Parameters

Table 3 above showed the results of some the growth parameter of *Pleurotus ostreatus* harvested from the two different substrates. In this study, only two flushes were harvested and it took average of 45 days. The first flush had the highest yield when compared to the second flush and this may be attributed to availability of limited amount of nutrient for the second flush. It is probable that the first flush was able to assess all the nutrients present in the substrate hardwood (*Anogeissus leiocarpus*) sawdust and softwood (*Daniellia oliveri*) sawdust [30,23]. The fruiting and the parameter measured (average pin head, average height of the mushroom, average diameter, average fruiting bodies, average number of well-formed mushroom, average number of deformed mushroom and average yield), showed that *Pleurotus ostreatus* harvested from softwood (*Daniellia oliveri*) sawdust was higher than that harvested from hardwood (*Anogeissus leiocarpus*) sawdust. This differenc in growth assessment may be due to rate of accessibility of the nutrients and the nutrients composition in the substrates. From the proximate composition results, it could be deduced that hardwood (*Anogeissus leiocarpus*) sawdust was richer than softwood (*Daniellia oliveri*) sawdust, the difference observed in the growth assessment may be attributed to utilization of the nutrient for growth by *Pleurotus ostreatus* cultivated on the hardwood (*Anogeissus leiocarpus*) sawdust. The first flush harvested from the two substrates was the same in all parameters, differences were recorded in the second flush which brought about the changes observed and reported in Table 3. This result was similar to that reported by Alananbeh et al. [24].

4. CONCLUSION

This study show that *Pleurotus ostreatus* can be cultivated using both hardwood sawdust (*Anogeissus leiocarpus*) and softwood sawdust (*Daniellia oliveri*). In term of nutritional composition, hardwood (*Anogeissus leiocarpus*) sawdust gave a better nutrient than softwood sawdust (*Daniellia oliveri*). In term of growth and yield, softwood sawdust (*Daniellia oliveri*) has a higher yield than hardwood sawdust (*Anogeissus leiocarpus*). It can be concluded that both sawdust used have limitations, but hardwood sawdust will serve a better purpose in cultivating mushroom with good nutritional composition that will support good health.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ezeonu CS, Tagbo R, Anike EN, Oje OA, Onwurah INE. Biotechnological tools for environmental sustainability: Prospects and challenges for environments in Nigeria—A standard review. Biotechnology Research International; 2012.
2. Sánchez C. Lignocellulosic residues: Biodegradation and bioconversion by fungi. Biotechnol Adv. 2009;27:85–194.
3. Pathak R, Joshi N, Dwivedi RR. Eco-friendly production of *Agaricus bisporus* (Lange) imbach (white button mushroom). Nat Sci. 2009;6:57–60.
4. Morais MH, Ramos AC, Matos N, Santos-Oliveira EJ. Production of shiitake mushroom (*Lentinus edodes*) on ligninocellulosic residues: Note. Food Science and Technology International. 2000;6:123–128.

5. Sánchez C. Modern aspects of mushrooms culture technology. Appl Microbiol Biotechnol. 2004;64:756–762.
6. Gbolagade J, Ajayi A, Oku I, Wankasi D. Nutritive value of common wild edible mushrooms from Southern Nigeria. Global Journal of Biotechnology and Biochemistry. 2006;1:16–21.
7. Oei P. Manual on mushroom cultivation: Techniques species and opportunities for commercial application in developing countries. TOOL Publications, Amsterdam. 2003;274.
8. Laborde J. Dossier Pleurote. INRA, Centre de Recherché de Bordeaux, Station de Recherché sur les Champignons, Bordeaux. 1995;17–18.
9. Rühl M, Fischer Ch, Kües U. Ligninolytic enzyme activities alternate with mushrooms production during industrial cultivation of *Pleurotus ostreatus* on wheat-straw-based substrate. Curr Trends Biotechnol Pharm. 2008;4:478–492.
10. Akindahunsi AA, Oyetayo FL. Nutrient and antinutrient distribution of edible mushroom, *Pleurotustuber-regium* (fries) singer. LWT Food Science and Techology. 2006;39:548–53.
11. Manzi P, Gambelli L, Marconi S, Vivanti V, Pizzoferrato L. Nutrients in edible mushrooms: An interspecies comparative study. Food Chemistry. 1999;65:477–82.
12. Jayakumar T, Ramesh E, Geraldine P. Antioxidant activity of the oyster mushroom, *Pleurotus ostreatus*, on CCl_4-induced liver injury in rats. Food Chemistry and Toxicology. 2006;44:1989–96.
13. Benjamin DR. Mushroom, poisons and panaceas: A handbook for naturalists, mycologist and physicians. W. H. Freeman & Company, New York; 1995.
14. Eswaran A, Ramabadran R. Studies on some physiological, cultural and post-harvest aspects of oyster mushroom, *Pleurotus ostreatus.* Tropical Agricultural Research. 2000;12:360–374.
15. Sánchez C. Cultivation of *Pleurotus ostreatus* and other edible mushrooms. Applied Microbiology and Biotechnology. 2010;85:1321-1337.
16. Ogundele GF, Abdulazeez RO, Bamidele OP. Effect of pure and mixed substrate on oyster mushroom (*Pleurotus ostreatus*) cultivation. Journal of Experimental Biology and Agricultural Sciences. 2014;2:215-219.
17. Das N, Mukherjee M. Cultivation of *Pleurotus ostreatus* on weed plants. Bio Resource Technology. 2007;98:2723–2726.
18. Pathmashini L, Arulnandhy V, Wilson-Wijeratnam RS. Cultivation of oyster mushroom (*Pleurotus ostreatus*) on sawdust. Ceylon J Sci Bio Sci. 2008;37:177–182.
19. Association of Official Analytical Chemists. Official methods of analysis international, 17th ed. Washington, DC. 2000;1230.
20. American Public Health Association. Standard methods for examination of water and waste water, 19th ed. Washington, DC. 1995;113-114.
21. Oyetayo VO, Ariyo OO. Micro and macronutrient properties of *Pleurotus ostreatus* (Jacq: Fries) cultivated on different wood substrates. Jordan J. Biol. Sci. 2013;6:223–226.
22. Patil SS, Ahmed SA, Telang SM, Baig MMV. The nutritional value *of Pleurotus ostreatus* (Jacq. : fr.) kumm cultivated on different lignocellulosic agrowastes. Innov. Rom. Food Biotechnol. 2010;7: 66–76.
23. Alananbeh KM, Bouqellah NA, Al Kaff NS. Cultivation of oyster mushroom *Pleurotus ostreatus* on date-palm leaves mixed with other agro-wastes in Saudi Arabia. Saudi Journal of Biological Sciences. 2014;21: 616-625.
24. Wang D, Sakoda A, Suzuki M. Biological efficiency and nutritional value of *Pleurotus ostreatus* cultivated on spent beet grain. Bioresour. Technol. 2001;78:293–300.
25. Zahid MK, Barua S, Haque ISM. Proximate composition and mineral content of selected edible mushroom varieties of Bangladesh. Bangladesh Journal of Nutrition. 2010;22-23:61-68.
26. Gbolagade JS. Bacteria associated with compost used for cultivation of Nigerian edible mushrooms *Pleurotus tuber-regium* (Fr.) Singer, and *Lentinus squarrosulus* (Berk.). African Journal of Biotechnology. 2006;5:338–342.
27. Dundar A, Acay H, Yildiz A. Yield performances and nutritional contents of three oyster mushroom species cultivated on wheat stalk. African Journal of Biotechnology. 2008;7:3497–3501.

28. Kar A, Choudhary BK, Bandyopadhyay NG. Preliminary studies on the inorganic constituents of some indigenous hypoglycaemic herbs on oral glucose tolerance test. Journal of Ethanopharmacology. 1999;64:179-84.
29. Agomuo EN. Proximate, phytochemical and mineral element analysis of the sclerotium of *Pleurotus tuber-regium.* International Science Research Journal. 2011;3:104–107.
30. Upadhyay RC, Verma RN, Singh SK, Yadav MC. Effect of organic nitrogen supplementation in *Pleurotus* species. Mushroom Biology and Mushroom Products. Sa´ nchez et al. (Eds.). 2002;225–232.

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