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Comparative Reports on *Pleurotus Sajor-caju* Cultivated on Local Wood Wastes in Ibadan Metropolis, Nigeria

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ABSTRACT: Cultivation of *Pleurotus* species, an Oyster mushroom is now becoming well known due to its taste, medicinal and nutritional values. It is capable of degrading agricultural wastes efficiently and even grows at different temperature ranges. Relatively, *Pleurotus* species has shorter life span and the fruiting bodies are rarely attacked by pests and diseases unlike the other edible mushrooms. Therefore, the aim of this research is to access the influence of mineral constituents of five local wood wastes (*Anogeissus leiocarpa, Pouteria altissima, Vitellaria paradoxa, Cordia milleni* and *Triplochiton scleroxylon*) in Ibadan metropolis on the growth, fruiting body yield and proximate analysis of cultivated oyster mushroom (*P. sajor-caju*). Data of Carbon/Nitrogen ratio (11.10 – 11.60) found reveal composition of Magnesium (0.035 mg), Potassium (0.053 mEq/l), Manganese (0.0013 mg), Copper (0.00050 g/m3), Iron (0.00275 mol/L), Phosphorus (0.027 mmol/L), Organic carbon (32.10 mg/L C), Organic matter (55.3 t/ha) and total nitrogen (2.77 mg/L) contributed greatly to the high crude protein, fats and ash contents of mushroom cultivated on *T. Scleroxylon.* However, insignificant contents of sodium (0.2 mg), Calcium (0.2 mmol/L) and Magnesium (0.013 mg) in *Pouteria altissima* led to the general inadequate performance of (*P. sajor-caju*) in yields. The fresh mean weight of (*P. sajor-caju*) was from 8.00 g – 27.53 g. The heaviest weight was obtained from *T. scleroxylon* followed by *V. paradoxa, C. milleni,* while *Anogeissus leiocarpa* gave the lightest weight. Hence, *T. scleroxylon* will be suggested for cultivating *P. sajor-caju* because of its positive impact on the yield, crude fibre, and protein content of the experimented mushroom.

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Oyster mushroom comprises the *Pleurotus* species belonging to Tricholomataceae family; it is known to be second generally cultivated mushroom globally after *Agaricus bisporus* (Sanchez, 2010; Hoa *et al*., 2015). Nevertheless, Obodai *et al*., (2003), described oyster mushroom to be third in rank commercially cultivated in the global market. Oyster mushrooms are common and universally cultivated in Europe, Asia and America due to their simple technology and low cost of production (Mane *et al*., 2007). Furthermore, *Pleurotus* species cultivation is becoming popular because of its medicinal properties, taste and nutrient constituents. Oyster mushroom has the ability to degrade agricultural wastes effectively and can grow at varied temperature ranges (Hoa *et al*., 2015). Comparatively, *Pleurotus* species fruiting bodies are not frequently attacked by pests and diseases like other edible mushrooms and more so, grow in a shorter time than them (Tesfaw, *et al*., 2015). *Pleurotus* species are by nature found in tropical and subtropical rainforest

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under a favourable growth condition. Nevertheless, they can be artificially cultivated by various agricultural wastes comprising ligin, cellulose and hemicellulose such as cotton seed, waste paper, sugarcane residue, wheat and rice straw, leaves and waste paper (Chirinang & Intarapichet. 2009). *Pleurotus* spp cultivation has been described to having the ability of effective colonization and lignocellulosic bioconversion of agro industrial residues, complex organic compounds, thereby bringing down waste disposal problem and producing a safety environment (Hoa, *et al*., 2015). Although Oyster mushroom can grow on a broad substrate variety, its quality and yield is subjected to the nutritional and chemical composition of the substrates (Badu, *et al*., 2011). *Pleurotus* species are potential source of protein and minerals that enriches diets human and can be a healthy alternative to meat (Guinard *et al*., 2016 and Familoni *et al*., 2018). Nevertheless, edible mushrooms cultivation on a commercial scale is still lagging in Nigeria, despite massive quantities of agro-industrial products and lignocellulosic agricultural residues being generated on a daily basis. Some of these unexploited by-products are allowed to decay in the field or disposed by burning (Tesfaw *et al*., 2015). This happens due to shortage of mushroom farmers and researchers, little skills in mushroom cultivation, absence of some non-poisonous fungi spawns, inadequate familiarity of the variety of native mushroom species, lack of mushroom taxonomists and dearth of information in mushroom biotechnology (Okhuoya *et al*., 2010 and Familoni *et al*., 2018). Thus, utilizing various indigenous lignocellulosic substrates in cultivation of oyster mushroom is part of the solutions to convert these wood wastes into an edible substance of high nutrient and commercial value (Osemwegie *et al*., 2014 and Tesfaw *et al*., 2015). In genus *Pleurotus*, several species has been examined *P.sajor-caju, P. cystidiosis, P. florida, P. flabellatus* and *P. eryngii*. *Pleurotus sajor- caju* was considered to be an outstanding mushroom due to its ability to be cultivated between a broad array of temperatures on diverse natural materials and agronomic wastes (Rehana *et al*., 2007 and Nurudeen *et al*., 2014). Therefore, this work aimed at assessing the influence of different indigenous wood dusts on the growing performance, yield and nutritional constituents of *P. sajor –caju*.

MATERIALS AND METHODS

Culture preparation: The pure culture of *Pleurotus sajor-caju* was obtained from Pathology section of Forestry Research Institute of Nigeria, Jericho, Ibadan, Nigeria. The cultures were maintained on Potato dextrose agar slants at 40°C. Sub culturing was done after 15days.

Spawn preparation: Spawn was prepared in jam bottles. Whole wheat grains were soaked in cold water overnight, washed and drained of excess water. The grains were boiled in water bath for 15min, packed (250g) in jam bottles and sterilized in an autoclave at 121°C for 30min. After sterilization, the bottles were inoculated with actively growing mycelia of *P. sajor-caju* from the slants and incubated at (28 ± 20°C) for mycelia growth in the dark room 10-15days until the bottles are fully ramified.

Substrate preparation: Five wood dusts types *viz., Cordia milleni*, *Pouteria altissima*, *Triplochyton scleroxylon*, *Anogeissus leiocarpa* and *Vitellaria paradoxa* were sourced from Ibadan city. Elemental analyses of the wood dusts were carried out to determine their composition. C/N ratio was obtained by division of percentage carbon by percentage nitrogen components of each wood dust. The different wood dusts were mixed individually with 5% wheat bran and 1% agricultural lime ($CaCO_3$) in order to enrich the growth of the mushroom. 400g of each substrate was packed into a 50 x 27 cm transparent polythene bag. The experiment was completely randomized with five treatments and ten replications. The substrate bags were then sterilized at 121°C in an autoclave for one hour, left to cool and later inoculated with *P. sajor-caju* spawn. Inoculated substrates were then carried into the incubation room for mycelia growth. Linear mycelia growth was accessed weekly for three weeks.

Cropping and Harvesting: Mushroom bags were transported to the fruiting room instantly after the mycelia are fully ramified. The polythene bags' tip were unfastened after spawn run and were arranged on the shelves, exposed to 80-90% humid condition and were being sprayed with water on a regular basis. Primordial development was observed between 3-5 days after opening of the bags. Matured mushrooms were harvested persistently until the third flush.

Data collection and statistical analysis: Mycelia Running Rate of substrate in the bag (cm) for each substrate was taken after the mycelia colonies spanned the shoulder of the bag. Linear length was taken at different sides of the bag (Sarker, 2004), with ruler and documented for three weeks.

$$MRR = L/N \text{ (cm/day)}.$$

Where L = Average length of mycelium running for different places (cm); N = Number of days

Then, the percentage mean mycelia growth of *P. sajor-caju* displayed by different wood dusts on a weekly basis was ascertained. Fruiting bodies parameters like mushroom weight (g), stipe length (cm), stipe thickness (mm) and pileus diameter (cm) were collected. The pileus diameter and stipe length were estimated with meter rule while the stipe thickness was evaluated with Vernier caliper. The fresh weight (g) of each fruiting body was ascertained by a digital weighing balance and recorded after each harvest. Average fresh weight was then ascertained by dividing the total weight of fruiting body per bag by the total number of fruiting body per bag. Harvesting continued until all the nutrients in each substrate was exhausted. The collected data means were analyzed in a completely randomized design (CRD) using analysis of variance (ANOVA) with Genestat version 8, means were separated by Duncan at 5% significant level ($p<0.05$). Dried sample of *P. sajor-caju* was analyzed for food composition according to the Association of Official Analytical Chemists (AOAC, 2000). The percentages of carbohydrate, moisture, crude protein, Ash, fats and crude fibre were determined.

RESULTS AND DISCUSSION

The mycelia growth of *P. sajor-caju* displayed by the experimental wood dusts was examined for three weeks. Table 2 illustrated that *P. altissima* was ahead in the ramification rate accompanied by *C. milleni*, *V. paradoxa*, *T. scleroxylon* and *Anogeissus leiocarpa* respectively. Figure 1 revealed that *T. scleroxylon* (27.53 g) showed the heaviest mean fresh *P. sajo-caju* yield followed by *V. paradoxa* (23.40 g), *C. milleni* (15.40 g), *P. altissima* (9.00g) while *A. leiocarpa* (8.07 g) gave the lightest yield. *C. milleni* recorded the longest stipe length (5.72 cm) followed by *V. paradoxa* (5.61 cm) meanwhile, *A. leiocarpa* (4.67cm) recorded the shortest stipe length. *C. milleni* (5.42 cm) produced the widest pileus diameter followed by *T. scleroxylon* (4.89 cm) whereas; *A. leiocarpa* (3.92 cm) produced the narrowest pileus diameter. *C. milleni* gave the thickest (9.96 mm) stipe followed by *T. scleroxylon* (8.91 mm), *V. paradoxa* (8.82 mm) *P. altissima* (8.23 mm) meanwhile *A. leiocarpa* (8.57 mm) gave the thinnest stipe.

Table 1: Elemental analysis of local wood wastes in Ibadan metropolis

Wood dusts	Na %	Ca %	Mg %	K %	Mn %	Cu %	Fe %	Zn %	P %	O.C %	O.M %	T.N %	C/N
Triplochiton scleroxylon	0.83	0.83	0.019	0.046	0.0004	0.00033	0.00025	0.0018	0.005	30.3	52.2	2.61	11.61
Cordia milleni	0.54	0.54	0.035	0.053	0.0013	0.0005	0.00275	0.0023	0.027	32.1	55.3	2.77	11.59
Vitellaria paradoxa	0.78	0.78	0.027	0.025	0.0008	0.00033	0.00025	0.0023	0.017	24.3	41.9	2.1	11.57
Pouteria altissima	2.18	2.18	0.016	0.031	0.0004	0.00033	0.00075	0.0025	0.008	23.3	40.2	2.01	11.59
Anogeissus leiocarpa	0.2	0.2	0.013	0.038	0.0003	0.0003	0.00025	0.0022	0.018	31.7	54.7	2.74	11.57

Values in the same table having the same alphabet are not significantly different from each other at 5% level of significant

Table 2. Mean mycelia growth (%) of *Pleurotus sajor-caju* exhibited by different wood dusts on a weekly basis

Substrate	Week 1	Week 2	Week 3
Triplochyton scleroxylon	45.54	69.64	100
Cordia milleni	46.09	82.61	100
Vitellaria paradoxa	47.06	70.59	100
Pouteria altissima	48.91	92.40	100
Anogeissus leiocarpa	33.33	55.56	100

Mean of five replicates.

Table 3: Proximate analysis of *Pleurotus sajor-caju* cultivated on five local wood dusts

Wood dusts	Crude protein (%)	Ash (%)	Fat (%)	Crude fibre (%)	Moisture (%)	Carbohydrate (%)
Triplochiton scleroxylon	21.19	5.30	8.00	8.48	12.67	44.37
Cordia milleni	18.94	4.74	11.00	7.58	12.33	45.41
Vitellaria paradoxa	16.45	4.11	13.00	6.58	14.00	45.86
Pouteria altissima	8.27	2.07	5.00	3.31	4.67	76.69
Anogeissus leiocarpa	20.47	5.12	8.67	8.19	5.67	51.88

Table 4: Growth parameters of *Pleurotus sajor-caju* cultivated on local wood wastes in Ibadan metropolis

Growth parameters	*T. scleroxylon*	*C. milleni*	*V. paradoxa*	*P. altissima*	*A. leiocarpa*
Fresh mean weight (g)	27.53^{a}	15.40^{b}	23.40^{a}	9.00^{c}	8.00^{c}
Mean Pileus diameter (cm)	4.89^{ab}	5.42^{a}	4.12^{ab}	4.06^{b}	3.92^{b}
Mean stipe length (cm)	5.59^{a}	5.72^{a}	5.61^{a}	5.06^{ab}	4.67^{b}
Mean stipe thickness (mm)	8.91^{a}	9.96^{a}	8.82^{a}	8.23^{a}	8.57^{a}

abc = mean value with different superscripts are statistically different at $p \leq 0.05$

Effects of mineral composition of local wood wastes on the proximate analysis of cultivated Pleurotus sajor-caju: Carbon to Nitrogen ratio influences the rate at which organic matter decomposes. There must be an optimum C/N ratio in the culture substrate for the cultivation of mushroom in order to get the best yield in a very short period of time (Zied and Pardo-Giménez, 2011; Nurul, *et. al.*, 2023). Miles and Chang (2014) reported that a C/N ratio of 32- 150 is most suitable for the production of *Pleurotus* spp. However, in this study, the value obtained ranged from 11.10 – 11.60. Higher composition of Na (0.83 %), Ca (0.83 %) K (0.046 %), Cu (0.00033 %), and lower composition of Mn (0.0004 %), Fe (0.00025 %), Zn (0018 %) and P (0.005 %) relative to other elements in Table 1, suggested that these elements contributed greatly to the high crude protein (21.19 %), high crude fiber (8.48 %) and ash contents (5.30 %) of the cultivated mushroom on *T. scleroxylon*. However, *P. altissima* was able to produce *P. sajor-caju* with a substantial amount of carbohydrate (76.69 %) compared to other substrates. *V. paradoxa* produced *P. sajor-caju* with significant amount of moisture contents (14.00 %) and fats (13 %) contents due to its low amount of K (0.025 %) and Fe (0.00025 %) in relation to the amounts produced by the other substrates. Nevertheless, higher percentage of O.C, O.M and T.N in *C. milleni* (32.1 %, 55.3 %, and 2.77 %) and *A. leiocarpa* (31.7 %, 54.7 % and 2.74 %) respectively, gave rise to the total lowly yield performance of *P. sajor-caju*. Therefore, *C. milleni* and *A. leiocarpa* would not be appropriate substrate for *P. sajor-caju* cultivation.

The means mycelia growth (%) of P. sajor-caju cultivated on local wood wastes in Ibadan metropolis on weekly basis: P. altissima having the fastest mycelia ramification followed by *C. milleni* while *A. leiocarpa* having the slowest ramification in Table 2, might be as a result of variation in the density of the wood waste and their properties (Olasupo *et al*., 2019). Hence, *P. altissima* suggested the most promising and preferred out of all the wood wastes examined.

Impacts of wood dusts substrates kinds on the growth parameters of P. sajor-caju: The *P. sajor-caju* fresh mean weight found from this research (table 4), was from 8.07g – 27.53g. Highest percentage value was obtained from *T. scleroxylon* followed by *V. paradoxa* while *A. leiocarpa* gave the least percentage.

This percentage value is lesser than the result (Haastrup and Aina Oduntan, 2016) and (Nurudeen *et al.*, 2013) who reported (45.15g – 48.65g) and (56.66g – 108.78g) respectively when *P. sajor-caju* was cultivated on different agricultural wastes. However, it can be compared to some extent with the report Oluwalana, *et al.*, (2016), gave (15.07g – 41.51g) when *P. sajor-caju* was cultivated on different agricultural substrates.

The pileus diameter obtained in table 4, was from 3.92 cm – 5.40 cm. The mushroom produced by *C. milleni* had the highest value followed by *T. scleroxylon* while *A. leiocarpa* had the least. This corroborates the report Chiejina and Osibe, (2015) who reported (3.01 – 5.76) when *L. squarrossulus* was cultivated on different wood wastes. *Moisture contents (%):* As depicted in table 3, the least moisture content (4.67) of *P. sajor-caju* produced was observed in the *P. altissima*'s substrate, while highest was observed in *V. paradox* (14.00). This implies that the shelf life of *P. sajor-caju* produced by *P. altissima* is low and the mushroom can be easily dried and stored as soon as possible. The values obtained are similar to (12.28 – 13.33) presented by Chiejina and Osibe, 2015 but higher than (6.87% - 8.75%) cultured on the same substrates as documented by Olasupo *et. al.,* 2020.

Crude protein (%): The crude protein value obtained in this study was from 8.27% – 21.19%. *T. scleroxylon* had the highest value as *P. altissima* had the least. It is lower than (16.31 – 28.40%) and (17.40 – 35.05%), documented by Nwoko, *et. al*., (2018) and Olasupo *et. al*., (2020) respectively but similar to 21.31% documented by Duru, *et. al*., (2018). The variation in the crude protein content might be due to the mushroom's species and nitrogen constituents in the substrates (Salami, *et. al*., 2016).

Crude fiblre (%): In this study, crude fibre ranged from 3.31% – 8.48%. *T. scleroxylon* gave the highest percentage while *P. altissima* gave the least. This correlates 6.70% - 7.90% and 7.61% - 8.50% studied by Patil, 2013 and Nururdeen *et al.* (2013), respectively who cultivated *P. sajor-caju* on diverse agricultural wastes.

Nevertheless, it is lower than 21.54% - 23.28% reported by Miah *et al.,* 2016). Low food fibre is good for infants and toddlers (Salamat, *et al*., 2017, Hojsak, *et. al.,* 2022). Nevertheless, high food fibre aids food absorption in patients with cancer, diabetes and heart diseases due to its ability to clean and maintain intestinal tract and thereby reducing blood cholesterol (Ugbogu and Amadi, 2014, Hojsak, *et. al.*, 2022).

Fats (%): Mushroom fats are hypocholestrolemic and possess unsaturated fatty acid (Bereda, 2022). The percentage of fats in this research was from 5.00% – 13.00%. Highest value was recorded in *V. paradoxa* substrate while the least was recorded in *P. altissima*. This result is higher than Patil, (2013) who reported 2.40% - 2.82% when *P. sajor-caju* was cultivated on different substrate. Diets with low fats/lipids contents are good for management of heart related diseases and obesity (Chawla, *et. al.*, 2020).

Table 5: ANOVA table of mean fresh weight (kg) of *P. sajor-caju* cultivated on local wood wastes in Ibadan metropolis

Source	DF	Sum of squares	Mean square	FValue	Pr>F
Model	4	1488.817778	372.204444	33.74	<.0001
Error	20	220.622222	11.031111		

Table 6: ANOVA table of mean pileus diameter (cm) of *P. sajor-caju* cultivated on local wood wastes in Ibadan metropolis

Source	DF	Sum of squares	Mean square	FValue	Pr>F
Model	4	7.62677067	1.90669267	2.56	0.0702
Error	20	14.89049333	0.74452467		

Table 7: ANOVA table of mean stipe length (cm) of *Pleurotus sajor-caju* cultivated on local wood wastes in Ibadan metropolis

Source	DF	Sum of squares	Mean square	F Value	Pr>F
Model	4	3.99751378	0.99937844	3.10	0.0389
Error	20	6.45572889	0.32278644		

Table 8: ANOVA table of mean stipe thickness (mm) of *Pleurotus sajor-caju* cultivated on local wood wastes in Ibadan metropolis

Source	DF	Sum of squares	Mean square	F Value	Pr>F
Model	4	8.41324178	2.10331044	1.48	0.2454
Error	20	28.40228444	1.42011422		

Ash contents (%): The ash content is the entire amount of mineral constituents in the mushroom (Muthu and Shanmugasundaram, 2016). Percentage ash contents in this study ranged from 2.38% – 6.18%. *T. scleroxylon* produced the highest value followed by *C. milleni* while *V. paradoxa* produced the least. The values obtained are lower than (6.58% – 8.41%) and (6.65% - 7.30%) studied by Kulsum *et al.* (2009) and (Patil, 2013) respectively who cultured *P. sajor-caju* on different substrates.

Carbohydrates (%): Carbohydrate is a good source of energy for breakfast and weaning food formulas (Stephen *et. al.*, 2012). The carbohydrates value got from this work ranged from 44.37% - 76.69%. It corroborates the result of Nurudeen *et al*., (2013) who reported that *P. sajor-caju* cultivated on different agricultural wastes ranged from 65.68% to 69.22%. Nevertheless, it is higher than Alam *et al.*, (2007) who obtained carbohydrates with 39.82% - 42.83% in *pleurotus spp.* Mushrooms with high carbohydrate contents can be used locally for soup thickening and binding (Odoh, *et*, *al*., (2017).

Conclusion: The research established a comparative study of *P. sajor-caju* cultivated on local wood wastes in Ibadan metropolis and the effects of mineral constituents of the local wood wastes on the yield and proximate composition of *P. sajor-caju.* All the local wood wastes have the potential mineral elements of cultivating *P. sajor-caju* and any of the substrates could be used for mycelia growth of *P. sajor-caju*. Nonetheless, every farmer would always be interested in the wood wastes that would give high yield, rich in protein and availability in their environment. Hence, I would recommend *T. scleroxylon* in cultivating *P. sajor-caju* based on the yield, protein content and crude fibre of the analyzed mushroom.

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