Journal of Advances in Biology & Biotechnology

15(1): 1-7, 2017; Article no.JABB.35876
ISSN: 2394-1081

Nutrient and Mineral Content of Oyster Mushroom (*Pleurotus florida*) Grown on Selected Lignocellulosic Substrates

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Authors' contributions

This work was carried out in collaboration between all authors. Author FAB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author AOS managed the analyses of the study. Author YAS managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JABB/2017/35876
Editor(s):
(1) Andrzej Kowalski, Department of Biochemistry and Genetics, Institute of Biology, Jan Kochanowski University, Kielce, Poland.
Reviewers:
(1) Jayath P. Kirthisinghe, University of Peradeniya, Sri Lanka.
(2) Hasan Huseyin Dogan, Selcuk University, Turkey.
Complete Peer review History: http://www.sciencedomain.org/review-history/20927

Original Research Article

Received 31st July 2017
Accepted 26th August 2017
Published 11th September 2017

ABSTRACT

This study was carried out to determine the proximate and mineral content of *Pleurotus florida* mushroom in order to assess its nutritional value and to determine its yield and biological efficiency on the substrates. *Pleurotus florida* was cultivated on the four lignocellulosic substrates: sawdust, corn cobs, oil palm spadix and corn straw. A ramified spawn bottle of *Pleurotus florida* was multiplied and inoculated on pasteurized substrates at the Mycology Laboratory of the Department of Crop Production and Protection, Faculty of Agriculture, OAU, Ile-Ife, Osun State. The mature fruiting bodies were subjected to proximate and mineral analysis. The total yield and biological efficiency were also obtained. The result showed that *Pleurotus florida* contained 26.28-29.91% protein, 86.90-89.60% moisture, 0.48-0.91% fat, 19.64-22.82% fiber, 31.37-38.17% carbohydrate and 5.18-6.39% ash. The mineral contents ranged from 342-410 mg/100 g Calcium, 1009-1133 mg/100 g Phosphorus, 17-21 mg/100 g Iron, 277-359 mg/100 g Sodium and 2088-2281 mg/100 g Potassium. Also, the highest yield and biological efficiency were obtained on corn cobs substrate

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(110 g, 55%), followed by Oil palm spadix substrate (76.05 g, 38%) and least on corn straw substrate (63.12 g, 31.56%). Conclusively, *Pleurotus florida* is rich in protein, fiber, ash, carbohydrate, Calcium, Phosphorus, Potassium, Iron and low in fats, Sodium and should be added to our diet to for qualitative diet.

Keywords: Proximate analysis; lignocellulosic substrate; oyster mushroom.

1. INTRODUCTION

Oyster mushroom, locally known as "Olu" in the South Western part of Nigeria are edible mushroom having excellent flavor and taste. Oyster mushrooms (*Pleurotus florida*) are edible fungi belonging to the class Basidiomycetes and are increasingly becoming popular as protein-rich delicious vegetable [1]. They are the second most popular mushrooms after button mushroom all over the world [2]. *Pleurotus florida* is widespread in the temperate, subtropical and tropical zones. Oyster mushroom contains 20-35% protein in dry weight which makes its protein higher than that of vegetables and fruits and is good as ingredients of functional foods [3]. Mushrooms are rich in proteins, vitamins, and minerals and are popularly called "The vegetarian's meat" as it contains nine essential amino acids required for human body [4]. Edible mushrooms are highly nutritious and can be compared with milk and meat [5]. *Pleurotus* sp. contains high potassium to sodium ratio, which makes mushrooms an ideal food for patients suffering from hypertension and heart diseases [6]. Mushroom production in rural communities can alleviate poverty and improve the diversification of agricultural production [7]. Oyster mushrooms are grown on organic substances termed as "Substrates". These substances are mostly waste materials from farm, plantations or factories [8]. The process of preparation of substrate is broadly termed "Composting. A wide range of plant waste that have been reported include sawdust, paddy straw, sugarcane bagasse, corn stalk, corn cobs, waste cotton, leaves and pseudo stem of banana, water hyacinth, duck weed, rice straw etc. and does not require costly processing method and enrichment material [9].

The mushroom seed is generally referred to as "Spawn". Spawn is a living ramified mycelium of a mushroom, multiplied on a suitable sterile base material under aseptic condition. The base materials that can be used for spawn production are chopped rice straw, sawdust, tealeaves, coffee hull, cotton waste and cereal grains [10] Oyster mushroom can grow at moderate temperatures, ranging from 20 - 30°C, and at a humidity of 55–70%, on various agricultural waste materials used as substrate. Oyster mushroom can be grown in available rooms like cottages, garages, basements or any unused room at any urban setting. Despite the nutritional and economic importance of mushroom, its nutritive usefulness has not been fully exploited by people which has resulted to its little or no acceptability as a substitute for meat and egg. Hence, this study was carried out to determine the yield and biological efficiency of *Pleurotus florida* grown on selected lignocellulosic substrates and to determine the proximate analysis and mineral content of *Pleurotus florida* in order to assess its nutritional value.

2. METHODOLOGY

Four substrates including Corn cobs, Oil palm spadix, Corn straw, Sawdust were composted at the Mycology laboratory, Department of Crop Production and Protection, Faculty of Agriculture, Obafemi Awolowo University, Ile-Ife, Osun State. Spawns were produced using white sorghum which was washed and boiled. $CaCO_3$ & $Ca(OH)_2$ were added in ratio 2:1 to regulate the pH. Labeled sterilized jam bottles were filled with these grains to about ¾ of the size of the bottle. The bottles were corked with cotton wool and aluminum foil paper and later autoclaved at 121°C for 20 minutes after which the bottles were allowed to cool for 24 hrs at room temperature. Thereafter, grain to grain spawning was done to multiply the grain spawn. The bottles of the newly spawned grain was put in an incubator at temperature between 25-28°C in complete darkness for 8-9 days to allow the mycelium colonize the grains. Corn cobs, corn straw and oil palm spadix were shredded into bits of about 2 cm and the dry weight was measured and recorded. Each substrate was poured into a clean bowl and 2-3% of Calcium carbonate ($CaCO_3$) and Calcium hydroxide $Ca(OH)_2$ were added for optimization and to adjust the $_PH$ to a range of 5.5-8.5 for optimum mycelia colonization. Hot water was poured to submerge the substrates and allow to soak for 2 hrs, after which the substrates were drained and allowed to cool. Labelled transparent plastic plates were cleaned, holes were drilled into each of them in

axenic conditions, the grain spawn sprinkled over the substrates in layers. The inoculated substrates were taken to the dark room for colonization and ramification of mushroom mycelia on the substrates. After 10-11 days, the fully ramified substrates were transferred into the growth chamber. Watering was adequately done thrice daily to increase the relative humidity of the environment within the plates. As soon as fruiting bodies developed and attained maturity, they were harvested with sharp knife by cutting just above the surface of the substrates and watering was continued to enhance further yield of mushroom flushes. The following parameters were noted as the growth occurred: days taken for complete spawn running (ramification), days taken for mycelia ramification of substrates, days taken for maturity of fruiting body, number of flushes, flush interval (time interval in days between the flushes in days), weight (g) of harvested fruiting bodies, number of fruiting bodies before harvesting, the biological efficiency was calculated following formula modified by [11]. The mushroom fruiting bodies were analyzed for proximate parameters such as moisture, protein, ash, crude fiber, fat, carbohydrate (Nitrogen Free Extract); the mineral contents were determined by atomic absorption spectrometry, flame photometry and spectrophotometer according to the methods of [12]. The experimental design was a randomized complete block design with three replicates. The data obtained were subjected to ANOVA and the means were separated according to DMRT using Statistical Analysis Software (SAS) version 9.1. Microsoft Excel was used for graph plotting.

3. RESULTS AND DISCUSSION

All the substrates supported the cultivation of mushroom at different levels. Table 1 shows the Analysis of variance and the mean square values for the growth and yield parameters of *Pleurotus florida* on the substrates. Treatment does not have effect on number of fruiting bodies and mycelia ramification of substrate since the values were not significantly different. However, treatment had effect on pin head formation, maturity of the fruiting bodies, flush interval and total weight of flushes gotten at 0.001 and 0.01 levels of probability. Also, from the table, the treatments effect on flush interval and total weight of flushes harvested implies that the substrate variability had an impact on the weight of mushroom harvested and the number of days it took to have successive harvests. In the same vein, the treatments have no effect on mycelia ramification of substrates and the number of fruiting bodies which shows that variation of the substrates does not decrease or increase the Mycelia ramification of substrate and Number of fruiting bodies of *Pleurotus florida* harvested from the substrates. The treatment had no effect on the number of flushes and days taken for spawn running.

Comparing the yield and growth parameters as revealed by Table 2, complete ramification of all the substrates took place in 10 days after “grain to grain” spawning with the sterilized sorghum grains. The mycelia ramification of the substrates occurred faster on Corn straw substrate and Sawdust substrate and was significantly different from that of Oil palm spadix substrate and Corn cobs substrate. There was significant difference in the days to pin head formation of the substrates. It was first observed on sawdust substrate, corn cobs, oil palm spadix and corn straw at 4, 5, 7.00 and 11.00 days after mycelia colonization on substrates respectively. Days to maturity of the fruiting bodies on corn cobs and sawdust was similar but significantly different from that of oil palm spadix and corn straw. Also, number of fruiting bodies of corn cobs and corn straw were similar but significantly different from oil palm spadix and sawdust which were also similar. For flush interval, there was significant difference among the substrates. The maximum period for flush interval on average basis was observed on oil palm spadix (25.00 days), followed by corn straw (21.00 days) while the minimum was on corn cobs (12.00 days). Also, there was no significant difference among the substrates with regards to number of flushes harvested. Total weight of flushes harvested, corn cobs proved a better substrate and significantly different from others with 110 g. The total weight of flushes for corn straw, oil palm spadix and sawdust were 63.12 g, 76.05 g and 72.82 g respectively which showed that they were similar but not significantly different.

Corn cobs substrate had the highest yield which was significantly different from other substrates while saw dust substrate had the lowest yield, the biological efficiency was highest on corn cob substrate when compared to other substrates as revealed by Table 3. The moisture content ranged from 86.90-89.60% confirming high moisture content of the fruiting bodies with no significant difference across the substrates.

Mushrooms are considered to be a good source of digestible protein. In this study, the protein content varied from 26.28% - 29.91% across the

substrates but was not significantly different. The carbohydrate content ranged from 31.37-38.17%. The maximum carbohydrate was recorded on corn straw (38.17%) while the least was on oil palm spadix (31.17%). The ash, fat and crude fiber content of *Pleurotus florida* obtained from the substrates are shown in Fig. 1. The maximum ash content was found on corn straw (6.39%) followed by corn cobs (5.94%) while the least was on oil palm spadix (5.18%). Fat content on dry weight basis ranged between 0.48 – 0.91% and were similar across the four substrates used. The amount of crude fiber was maximum on oil palm spadix (22.82%) followed by sawdust (20.73%) and the minimum was recorded on corn straw (19.64%).

Table 1. Mean square values for the growth and yield parameters of *Pleurotus florida* on the substrates

Source of variation	DF	MRS (Days)	PHF (Days)	MFB (Days)	FI (Days)	TWF (g)	NBF
Treatment	3	0.75	31.86***	1.00***	102.88***	1251.26**	26.78
Replicate	2	0.08	0.58	0.00	30.33***	152.29	31.75
Error	6	0.08	0.69	0.00	0.22	124.67	10.86
R^2 (%)		83	96	100	99	84	69

***, *** represent significance at 0.01and 0.001 levels of probability respectively.*
R^2= Coefficient of determination.
MRS= Mycelia ramification of substrate, PHF= Pin head formation, MFB= Maturity of fruiting bodies, FI= Flush interval, TWF= Total weight of flushes gotten, NFB= Number of fruiting bodies

Table 2. Mean comparison of substrates for growth and yield parameters of *Pleurotus florida*

Substrates	SR (Days)	MRS (Days)	PHF (Days)	MFB (Days)	NFB	NF	TWF (g)	FI (Days)
CC	10.00a	9.00a	5.00c	3.00b	23.67b	3.00a	110.00a	12.00d
SD	10.00a	8.00a	4.00c	3.00b	26.67ab	3.00a	72.82b	17.00c
CS	10.00a	8.00a	11.00a	4.00a	30.33a	3.00a	63.12b	21.00b
OS	10.00a	9.00a	7.00b	4.00a	29.33ab	3.00a	76.05b	25.00a

Means with the same letters are not significantly different according to DMRT (P≤ 0.05).
CC= Corn cobs, SD= Sawdust, CS= Corn straw, OS= Oil palm spadix
SR= Spawn running, MRS= Mycelia ramification of substrate, PHF= Pin head formation, MFB= Maturity of fruiting bodies, FI= Flush interval, TWF= Total weight of flushes gotten (g), NFB= Number of fruiting bodies, NF= Number of flushes

Table 3. Effect of yield and biological efficiency of *Pleurotus florida* on the substrates

Substrates	Yield (g/200 g of dry substrate)			Total (g)	B.E (%)
	Flush 1	Flush 2	Flush 3		
Corncobs	44.27	39.93	25.80	110.00	55.00
Oilpalm spadix	29.13	25.03	21.88	76.05	38.00
Corn straw	22.23	19.50	21.38	63.12	31.56
Sawdust	27.73	23.90	21.18	72.82	36.41
$LSD_{0.05}$	11.35	9.88	5.46	22.31	

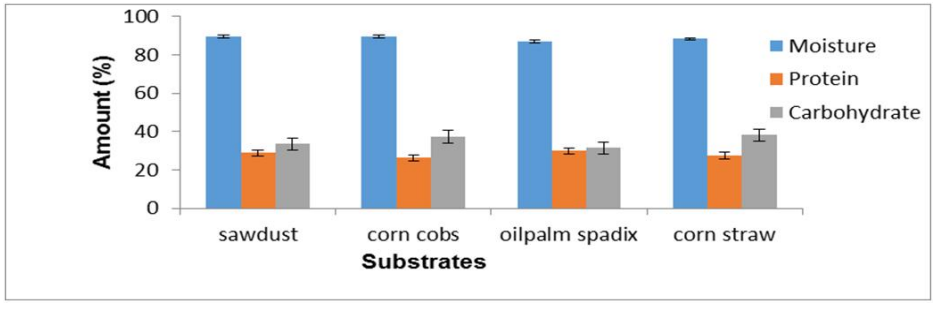

Fig. 1. The moisture, protein and carbohydrate composition of *Pleurotus florida*

The ash, fat and crude fiber content of *Pleurotus florida* obtained from the substrates. The maximum ash content was found on corn straw (6.39%) followed by corn cobs (5.94%) while the least was on oil palm spadix (5.18%). Fat content on dry weight basis ranged between 0.48 – 0.91% and were similar across the four substrates used. The amount of crude fiber was maximum on oil palm spadix (22.82%) followed by sawdust (20.73%) and the minimum was recorded on corn straw (19.64%). Also, the crude fibre ranges from (19.64-22.82). These results confirmed that mushroom is a food of high quality flavor and nutritive value has high content of protein, low in fat and high in crude fiber content. Mineral content is vital for the nutritional value of mushrooms. The calcium, iron and sodium composition of *Pleurotus florida* mushroom grown on sawdust, corn cobs, oil palm spadix and corn straw. Calcium content ranged from 342 – 410 mg/100 g. The highest Ca content was found on oil palm spadix (410 mg/100 g) followed by sawdust (391 mg/100 g) and least on corn cobs (342 mg/100 g). However, iron content varied from 17-21 mg/100 g on the different substrates. Sawdust showed maximum Fe content (21 mg/100 g), while corn cobs and oil palm spadix had the minimum (17 mg/100 g). Also, Sodium content varied with the substrates. The highest Na concentration was recorded on oil palm spadix (359 mg/100 g) and minimum was obtained on sawdust (277 mg/100 g). Phosphorus and potassium composition of *Pleurotus florida*. Maximum P content (1133 mg/100 g) was recorded on sawdust and was followed by oil palm spadix (1071 mg/100 g) while the least was on corn cobs (1009 mg/100 g). *Pleurotus florida* is high in phosphorus content, therefore can contribute to human nutrition. However, potassium content was higher compared to other minerals in *Pleurotus florida*. The quantity of potassium ranged from 2088-2281 mg/100 g. The highest value was recorded on corn straw (2281 mg/100 g) followed by sawdust (2217 mg/100 g) and least was on oil palm spadix (2088 mg/100 g).

Plate 1. Sterilized sorghum grains before grain spawning

Plate 2. Ramified sorghum grain spawns

Plate 3. A completely ramified substrate

Plate 4. Pinhead on the substrate


Plate 5. Mature fruiting bodies on the substrate

4. CONCLUSION

It can be concluded from this research that *Pleurotus florida* cultivated on the lignocellulosic substrates: sawdust, corn cobs, corn straw and oil palm spadix is qualitatively rich in essential nutrient such as high protein, crude fiber, ash, carbohydrate, calcium, phosphorus, potassium, iron and low in fats and sodium content. Also, corn cob substrate was the best substrate in terms of total yield and biological efficiency with (110 g, 55%) followed by Oil palm spadix (76.05 g, 38%) and least on corn straw (63.12 g, 31.56%). Oyster mushroom holds tremendous promise in complementing the protein and minerals supply deficiencies prevalent in a developing country.

This research therefore recommends that mushrooms should be grown on lignocellulosic wastes and incorporated into our diet more frequently in order to improve the quality of our habitual diet, overall health and general well-being of the people. For the nutritional potential of mushrooms to be realized, sustained efforts must be geared towards the husbandry and popularization of more nutritious species oyster mushroom.

DISCLAIMER

This manuscript was presented in the conference "International Conference on Mycology & Mushrooms"

Available:https://www.omicsonline.org/conference-proceedings/2161-0517-C1.012_009.pdf

Date: September 12-14, 2016 San Antonio, USA Virol Mycol 2016,5:2(Suppl)

http://dx.doi.org/10.4172/2161-0517.C1.012

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/20927