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Effect of Different Substrates on the Nutritional Composition of *Pleurotus ostreatus* (Jacq.) P. Kumm. (Oyster Mushroom)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Pleurotus ostreatus is a widely cultivated mushroom across the globe, known for its nutritional and therapeutic properties with a low rate production technology and increased biological efficiency. This study was aimed at determining the nutritional composition of *P. ostreatus* grown on four dissimilar substrates. *P. ostreatus* was cultivated on sawdust, cornhusk, banana leaves and a combination substrate consisting all three via spawn inoculation. The first flushes from each substrate were harvested and air-dried to constant weight. The nutritional composition like moisture content, ash content, protein, carbohydrate and vitamins were evaluated according to standard procedures. Three out of the four substrates produced fruiting bodies. Cornhusk showed the highest value (49.03%) for carbohydrate content surpassing the other substrates while the mushroom sample from sawdust treatment showed the highest level of protein with a value of 32.10%. The vitamin contents evaluated for the three substrates presented a significant value in vitamin A and E, with vitamin C being the least vitamin composition ranging from 37.90 mg kg-1 in combination substrates to 38.80 mgkg-1 in sawdust sample. Above all, the combination substrate showed the least nutritional content amongst all the other values obtained. This study has shown that P. ostreatus grown on cornhusk had the highest carbohydrate while sawdust had the highest protein content hence, the use of these substrates is recommended for optimal nutritional benefits.

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1. INTRODUCTION

Mushroom is an important food product and supplement that is valued all over the world particularly in Asia, Central Europe and Africa for its taste, nutritional value and medicinal properties. Chang [1] confirmed that mushrooms are an essential food item for human health, nutrition, and prevention of diseases. After *Agaricus bisporus, Pleurotus ostreatus* (oyster mushroom) is the 2nd most grown edible mushroom globally [2]. They were initially grown in Germany for nourishment during the world war [3]. Belonging to the family Pleurotaceae, oyster mushrooms are considered as one of the economically significant safe to eat mushrooms universally. They are saprophytic organisms that thrive mostly on woody logs and by-products such as sawdust, paper, pulp, straw, cornhusk, banana leaves and other agricultural wastes. *P. ostreatus* is one of the well-known species amongst oyster mushrooms, some of which are *Pleurotus ostreatus* var. *florida*, P. *sajor-caju*, and *P. eryngii* [4]. *P. ostreatus* has many advantages as a cultivated mushroom; from rapid mycelium growth, to its high biological efficiency, inexpensive cultivation techniques and ability to survive a range of climatic conditions [5]. They are also rich in protein, carbohydrates, vitamins and minerals; this makes them a very good dietary food. In addition, *P. ostreatus* has shown positive effects on human health due to the therapeutic properties shown in some of their substances [6]. Owing to these attributes, the production of oyster mushroom on a small or large scale has increased tremendously over the years.

Oyster mushrooms possess a wide range of nutritional properties; they are excellent sources of protein, carbohydrates, fiber and contain low fat. They are also rich in vitamins like A, B1, B2, E, riboflavin and niacin [7]. Proteins are an essential in everyday diet due to the many functions they perform in the body. Several proteins constituents have been isolated from *P. ostreatus* including the essential amino acids and some enzymes. The composition of protein in *P. ostreatus* has been described to differ based on the differences in growing medium, content of substrate, pileus size and time of harvesting [8]. Oyster mushrooms are regarded as a high-quality supply of carbohydrates in form of polysaccharides which are mostly represented by glycogen, dietary fibers, cellulose, β-glucans, and some hemicelluloses such as galactans as well as xylans. *P. ostreatus* are also a possible supply of dietetic fibre owing to the existence of non-starch polysaccharides. *P. ostreatus* has reduced fat composition but some vital fatty acids are found in it. However, they are not known to be a major resource of fatty acids to satisfy human body requirements. The primary mono-unsaturated fatty acid is oleic acid, and the primary poly-unsaturated fatty acid in *P. ostreatus* is linoleic acid. Linoleic acid is however an antecedent to the enticing scent in dried mushrooms [9]. Trace elements are important to human health and have major physiological effects on various organs and cellular processes. The vitamin of group B particularly folacine, vitamin B1, and vitamin B3 are abundant in *P. ostreatus* than in other mushroom species [10]. Therefore, the aim of this study was to determine the nutritional composition of *P. ostreatus* grown on four different substrates.

2. MATERIALS AND METHODS

2.1 Substrate Preparation

The experiment was carried out using 4 treatments with 3 replications of each, totaling 12 variants. Treatments were monitored for mycelium running and fruiting body formation till the time for harvest and analysis. The treatments included sawdust (SD), Cornhusk (CH), Banana leaves (BL) and a combination of all the substrates (CB). The bagged substrates were sterilized using an autoclave at 121°C and 1.1 kg/cm^2 for 30 minutes. The 12 bags were allowed to cool overnight on a clean cupboard shelf.

2.2 Spawn Inoculation

The spawn bottles were obtained 12 hours before inoculation and were kept in a safe space in the laboratory. 3½ teaspoon of spawn material was inoculated in each bag of substrate i.e. for each 1 kg bag of substrate; 14 g of spawn was used. The work area was carefully cleaned and sterilized with absolute ethanol.

2.3 Incubation and Harvest

Substrate bags were stored in a room with temperature of 34°C and relative humidity of

84%. The bags were left to completely ramify and after a successful completion of mycelia run, the mushroom bags were carefully moved to the screen house to begin its fruiting stage. This was followed with regular irrigation using a water sprayer 2 times a day to keep the bag moistened and ready for harvest. The mushroom samples obtained from the each bags of substrate were harvested, weighed and air dried to constant weight. They were then placed in polythene bags and taken to the laboratory for the proximate analysis of the nutritional contents and vitamin composition.

2.4 Proximate Analysis and Determination of Nutritional Content

The proximate analysis and determination of the nutritional contents of fruiting bodies from each substrate was evaluated according to the standard methods previously reported Baraket MZ et al. Bohm BA et al. AOAC [11,12,13]. Parameters assessed included moisture content, ash content, crude protein, crude fiber, fat and carbohydrate content as well as Vitamins A, C and E.

3. RESULTS

3.1 Fruiting Body Formation

Forty-five days after inoculation, cornhusk produced its first flush of mushroom which was harvested the next day. Mushroom samples from two replicates of cornhusk (CH_2 and CH_3) gave a yield of 27.2 g. The combination treatment (CB) took 60 days to produce its first flush of mushroom. A total yield of 3.0 g was obtained from CB_3 bag. Sawdust substrates were the last to complete their mycelia run after which fruiting bodies emerged from SD_2 bag, 68 days from inoculation. A total dry weight of 7.3 g was obtained from the first flush of SD_2 and this was the sample taken for analysis. Treatments from banana leaves substrates (BL) completed their mycelia run at 30 days but did not produce any fruiting bodies till the termination of the experiment.

3.2 Results of Proximate Analysis of Mushroom Samples

All the mushrooms on the different substrates had similar amounts of ash content of 4.45, 4.48 and 4.50% with CH being the least (Table 1). The values obtained from the crude fiber contents were also close (4.42, 4.36 and 4.39% for SD, CH and CB respectively). The fats and oil composition as presented in Table 1 ranges from 4.78%/g in CB, to 5.38%/g in the SD mushroom sample. Out of all the three substrates tested, SD showed the highest protein content, followed by cornhusk with a value of 26.34% and combination being 19.26%. Mushroom sample from CH treatment had the highest carbohydrate content (Fig. 1), higher than the other two (SD and CB). The moisture content in mushroom sample from CH was also higher than SD and CB reporting values of 10.62, 9.10 and 8.68%/g respectively.

The results of vitamins evaluated for the mushroom samples are shown in Table 2; vitamin C is the least vitamin content in all three samples ranging from 37.90 $mgkg^{-1}$ to 38.50 $mgkg^{-1}$. A significant amount of vitamin E was observed in all samples particularly in the mushroom from SD treatment with a value of 340.20 $mgkg^{-1}$.Vitamin A content in the samples ranged from 104.00 $mgkg^{-1}$ to 104.86 $mgkg^{-1}$ (Fig. 2).

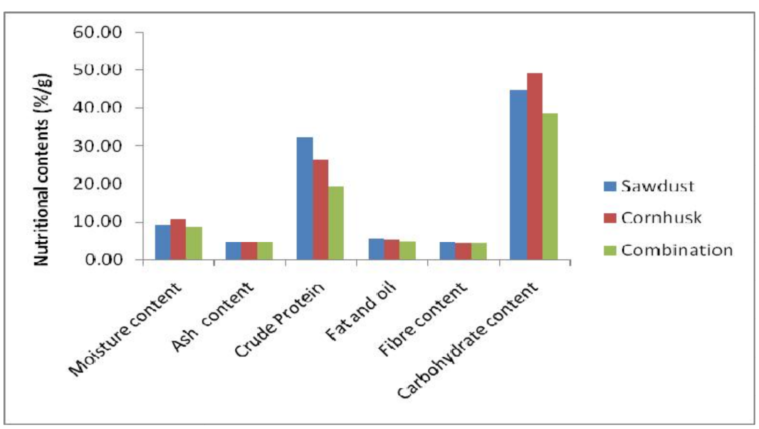

Fig. 1. Comparison of the nutritional contents obtained from each substrate sample

Table 1. Nutritional composition of the fruiting body samples

Substrate treatments	Moisture content	Ash content	Crude Protein	Fat and oil	Fiber content	Carbohy drate content
Sawdust (SD)	9.10	4.50	32.10	5.38	4.42	44.50
Cornhusk (CH)	10.62	4.45	26.34	5.20	4.36	49.03
Combination (CB)	8.68	4.48	19.26	4.78	4.39	38.41

**All values were expressed in %, 1g per mushroom sample*

Table 2. Vitamin composition of the fruiting body samples

Substrate treatments	Vitamin A	Vitamin C	Vitamin E
Sawdust (SD)	104.86	38.80	340.20
Cornhusk (CH)	104.20	38.50	338.40
Combination (CB)	104.00	37.90	336.10

**All values were expressed in mgkg^{-1}, per 2g of mushroom sample*

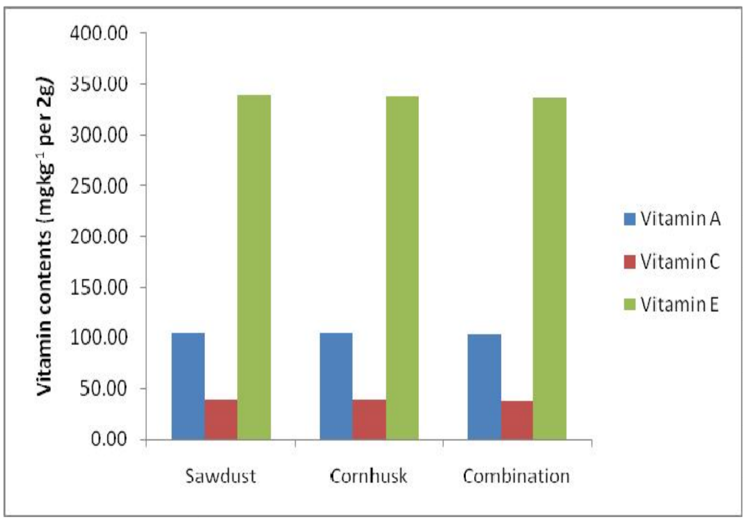

Fig. 2. Comparison of the vitamin contents obtained from each substrate sample

4. DISCUSSION

The proximate composition of the different samples of *Pleurotus ostreatus* from the three out of the four substrates used was shown in varying percentage of nutrient composition and vitamin content. The moisture content of *P. ostreatus* from the treatments of sawdust, cornhusk and combination showed 9.10, 10.62 and 8.68% respectively. This shows that the mushroom sample from cornhusk (CH) treatment showed the highest percentage of moisture being 10.62% and this goes in line with earlier studies that alluded that the moisture content of mushrooms depends on their harvesting time, maturation period and environmental conditions in growing period [14]. This statement could account for the difference in moisture content of the various samples of *P. ostreatus* from the different substrate treatments investigated. Protein is an essential source of amino acids and a vital component of diet [15]. The crude protein composition as observed in the mushroom samples from the treatments of sawdust, cornhusk and combination were recorded at 32.10, 26.34 and 19.26% per 2g of mushroom respectively. It has been stated that the protein content of mushrooms varies based on the species' genetic constitution, the physical and chemical variations of the medium of growth [16]. Previous works have shown that any plant food that supplies around twelve percent of its calorific value is recognized as a good source of protein. The quality of ash was correlated with the existence of nutritionary relevant mineral food materials [17]. The ash content was showed to be 4.50, 4.45 and 4.48% per 2g for sawdust, cornhusk and combination substrates respectively. Fats in diets enhance tastiness of food by imbibing and preserving flavours. The crude fat composition in the substrates treatments of SD, CH and CB were reported as 5.38, 5.20, 4.78% per 2g of mushroom respectively. The significance of fiber in food substances has been remarked by Walker AR [18]. Crude fibre content on the three investigated samples of *P. ostreatus* was shown to be 4.42, 4.36, and 4.39% from SD, CH and CB respectively. The total carbohydrate content of the mushrooms from the three substrate treatments shows that *P. ostreatus* is a potential source of carbohydrate.

For the development and functioning of individuals, vitamins are essential and thus must be obtained regularly and periodically via diet [19]. The vitamin content tested for *P. ostreatus* as obtained in Table 2 confirms the occurrence of vitamin A, C and E in SD, CH and CB substrate treatments.

5. CONCLUSION

This research has demonstrated that some agricultural wastes namely sawdust, wood shavings, and cornhusk can be used effectively for the cultivation of oyster mushroom with high nutritional yield which are greatly influenced by the substrate media. Cornhusk showed a significant amount of carbohydrate content while sawdust showed a significant amount of protein and can be substituted for expensive protein foods which are mostly unaffordable as a result of poverty. Thus, it is recommended that farmers use cornhusk and sawdust which has proven to be great alternatives and replacement to traditional substrates. The only challenge is that corn is a seasonal crop and the husk might not be readily available in substantial quantity at all times. However, this study has proven that given the abundance of agricultural wastes in Nigeria, mushroom cultivation will create an avenue for employment opportunities and equally a source of nutritious food.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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