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Micro and Macronutrient Properties of *Pleurotus ostreatus* (Jacq: Fries) Cultivated on Different Wood Substrates

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Abstract

The micro and macronutrient content of *Pleurotus ostreatus* cultivated on different woody substrates viz; *Pycnanthus ongoleubis, Ceiba pentandra* and *Cananium* sp. was investigated. Mineral analysis revealed that phosphorus had the highest value in all the minerals sampled and it value ranges between 51.97 mg/100 g to 56.77 mg/100 g while Magnesium recorded the least value of 1.69 mg/100g to 3.57 mg/100 g. *Pleurotus ostreatus* cultivated on woody substrate, *Pycnanthus ongoleubis* had higher and significantly different ($P \leq 0.05$) mineral content when compared with the other woody substrates, *Ceiba pentandra* and *Cananium* sp. The result of the proximate composition showed that *Pycnanthus ongoleubis* is the most suitable substrate for the cultivation of the *Pleurotus* mushroom based on the protein content. Amino acid analysis revealed that glutamic acid (9.01g/100 g to 10.3 g/100 g) was the most abundant amino acid in *P. ostreatus*. *P. ostreatus* cultivated on *Pycnanthus ongoleubis* had higher and significantly different ($P \leq 0.05$) values in all the amino acids when compared with *P. ostreatus* cultivated on the other woody substrates except phenlyalanine. Conclusively, *Pycnanthus ongoleubis* showed good potential as substrate for cultivation based on higher and significantly different ($P \leq 0.05$) mineral and proximate contents found in *P. ostreatus* cultivated on it.

Keywords: Woody, Substrate, *P. ostreatus*, Micro and Macronutrients.

1. Introduction

For centuries, mushrooms have been appreciated as sources of food nutrients and pharmacologically important compounds useful in medicine (Sagakami *et al*., 1991). In Eastern Countries like China and Japan, the knowledge of the use of edible and medicinal mushrooms had been passed on from one generation to the other in documented form (Oyetayo, 2011). For example, over 2,500 years ago, many medicinal mushrooms had been recorded and depicted in the earliest Chinese material medica book, *Shennong Bencao Jing,* and other succeeding Chinese medical book (Zhu, 2009). However, in most parts of Africa, consumption of mushrooms by many people is based on their organolleptic properties such as aroma, taste, flavour and texture and not on the nutritional and medicinal properties (Osemwegie *et al*., 2006).

Pleurotus species are edible mushrooms commonly known as oyster mushrooms. *Pleurotus* species contain high amounts of -amino butyric acid (GABA) and ornithine. GABA is a nonessential amino acid that functions as a neurotransmitter whereas ornithine is a precursor in the synthesis of arginine (Manzi *et al*., 1999). They grow widely in the tropical and subtropical rainforests (Chirinang and Intarapichet, 2009). Oyster mushroom cultivation has increased tremendously throughout the world during the last few decades (Chang, 1999). Oyster mushroom accounted for 14.2 % of the total world production of edible mushroom in 1997 (Chang, 1999). These mushrooms can be used industrially for mycoremediation purposes. Hence, its cultivation can play an important role in managing organic wastes whose disposal has become a problem (Das and Mukherjee, 2007). The cultivation of oyster mushrooms is on any type of ligno cellulose material like straw, sawdust, rice hull and others. Presently sawdust is commonly used and is the preferred medium at commercial scale. Of the sawdust types, softwood sawdust like mango and cashew are known to be more suitable than hardwood sawdust. Hami (1990) studied different species of mushroom cultivated on sawdust of different woods and found that *P. ostreatus* gave the maximum yield.

The different substrates used in cultivating mushrooms do have effect on the functional, organoleptic and chemical properties of mushrooms. In a study, Michael *et al*. (2011) reported that protein, ash, iron and phosphorus contents were high for mushrooms grown on bean straw compared to wheat straw. In the tropics, *Pleurotus* species

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usually grow on some woody substrates in the wild. Some of these tropical woods include *Canarium* sp., *Pycnanthus ongoleubis* and *Ceiba pentandra*. The present study therefore seeks to assess the effect of different woody substrates on the mineral and proximate contents of *Pleurotus ostreatus*.

2. Materials and Methods

2.1. Preparation and Cultivation of Pleurotus ostreatus on Woody Substrate

A modified method of Chang and Miles (2004) for cultivating mushrooms was adopted. Briefly, substrates used in cultivating *Pleurotus ostreatus* were prepared from sawdust of tropical plants, *Canarium* sp., *Pycnanthus ongoleubis* and *Ceiba pentandra* mixed with water. The substrates were filled into polythene bags (800g/bag). The bags were then sealed, autoclaved, cooled and inoculated with the spawn of *Pleurotus ostreatus* collected from Federal Institute of Industrial Research Oshodi, Lagos, Nigeria. Sawdust substrate in bags were inoculated with approximately 2 g of spawn using surface spawning technique under laminar flow and incubated in a dark chamber.

The growth of mycelium in each bag was observed. When the mycelium fully covered the substrate, bags were kept open in the growing house for fruit body formation. The harvested mushroom fruit bodies were air-dried after which they were ground to powder using grinding machine.

2.2. Determination of Mineral Content of Cultivated Mushroom

The mineral composition of cultivated *P. ostreatus* was determined by wet-ashing method. The solution of ash obtained from the cultivated *P. ostreatus* samples above were dissolved in a drop of Trioxonitrate (V) acid made up to 50ml with deionised water and analysed for Calcium (Ca) and Magnessium (Mg) using atomic absorption spectrophotometer (Buck 201 VGP). Sodium (Na) and Potassium (K) were analysed using flame photometer while Phosphorus (P) was determined in the samples using UV-Visible spectrophotometer after making ammonium vanadate molybdate complex at 436nm using established procedures of Perkin-Elmer (1982).

2.3. Analysis of Proximate Composition of Cultivated Pleurotus ostreatus

Analyses were carried out on triplicate samples. The protein, ash, fat, moisture and crude fibres were determined by the method of AOAC (2000). Carbohydrate content were determined by difference i.e. (%CHO = 100-(% Ash + % protein + % fat + % moisture).

2.4. Determination of Amino Acid Content of Cultivated Pleurotus ostreatus

Each fresh mushroom sample (0.2–1 g) was hydrolysed under nitrogen gas with 15 ml of 6 N HCl in an autoclave at 110 °C for 24 h and neutralized to pH 7.00 by 4 N NaOH.. The amino acids in the hydrolysates were analysed using Technicon sequential multisample (TSM) amino acid analyzer according to the method of Spackman *et al*. (1958).

2.5. Statistical Analysis

All experiments were carried out in triplicates. Data obtained were analyzed by one way analysis of variance and means were compared by Least Significant Difference (LSD) tests (SPSS 11.5 version). Differences were considered significant at $p<0.05$.

3. Results and Discussion

Pleurotus species also known as oyster mushrooms can be cultivated on different cellulosic waste. The different substrates used in cultivating these mushrooms obviously have significant effect on the nutritional and functional properties of oyster mushroom. The present study reports the mineral and proximate contents of *P. ostreatus* cultivated on different tropical woody substrates.

The mineral content of *P. ostreatus* cultivated on different woody substrate is shown on Table 1. Phosphorus was the most abundant mineral element in the cultivated mushroom samples. The value ranges between 51.97 mg/100g to 56.77mg/100g while Magnesium recorded the least value of 1.69mg/100g to 3.57mg/100g. *Pleurotus ostreatus* cultivated on *Pycnanthus ongoleubis* recorded highest values while *Pleurotus ostreatus* cultivated on *Ceiba pentadra* recorded the lowest values in all minerals analyzed. In an earlier study, phosphorus and potassium were reported as the most abundant mineral elements in *P. sajor-caju* fruitbodies cultivated on corncobs (Oyetayo, 2005). Manzi *et el*., 1999) also reported potassium as the most concentrated mineral element in various species of edible mushrooms. The variations in the levels of elemental composition of these mushrooms may be due to the accumulation and adsorption of these elements from the substrates.

The proximate composition of *Pleurotus ostreatus* cultivated on woody substrates is shown on Table 1. The moisture content of dried *Pleurotus ostreatus* ranges from 9.00% to 10.72%. Chang and Miles (2004) had earlier reported the moisture content of dried mushrooms to be in the range 9 - 13%. The protein composition of the samples ranges between 20.03 to 20.11%. The protein content in this study is in the range of protein (20.28%) reported for *Pleurotus ostreatus* cultivated on cotton waste (Bonatti *et al.*, 2004). Comparatively, *Pleurotus* cultivated on *Pycnanthus ongoleubis* had the highest protein content (20.11%). The crude fibre obtained in this study ranges between 17.35-17.51%. This is lower than crude fibre content (18.50%) reported for *Pleurotus* cultivated on cotton waste (Bonatti *et al.*, 2004). *Pleurotus* cultivated on *Pycnanthus ongoleubis* had the highest crude fibre. Fat content (2.31% to 3.09%) obtained in the present study was found to be low which is in correlation with the characteristics of oyster mushroom reported by Manzi *et al*. (1999). *Pleurotus* species are known to have low fat content (Akindahunsi and Oyetayo, 2006). *Pleurotus* cultivated on *Ceiba pentandra* had a lowest fat content (2.31%).

The carbohydrate content was higher in the *Pleurotus ostreatus* cultivated on *Pycnanthus ongoleubis* (45.75%)

than the *Pleurotus* cultivated on *Ceiba pentandra* and *Cananium* sp (41.87% and 44.56% respectively) but lower than the *Pleurotus* cultivated on cotton waste (48.35%). This is similar to the report of Ragunathan and Swaminathan (2000) that carbohydrate content of *Pleurotus ostreatus* ranged between 40.60-53.30%. There was a great variation in the ash content result of the samples. *Pleurotus ostreatus* cultivated on *Ceiba pentandra* wood substrate recorded the highest value (8.19%) and *Pleurotus ostreatus* cultivated on *Pycnanthus ongoleubis* recorded the least value (4.75%). The result of the proximate composition determination showed that *Pycnanthus ongoleubis* is the most suitable substrate for the cultivation of the *Pleurotus* mushroom based on the protein content.

Table 1. Mineral and Proximate composition of *Pleurotus ostreatus* cultivated on different woody substrates

Composition	A	B	C
Potassium(mg/100g)	11.34^{c}± 0.02	9.42^{a}± 0.15	10.33^{b}± 0.025
Sodium (mg/100g)	4.39^{c}± 0.012	4.03^{a} ± 0.02	4.11^{b} ± 0.01
Calcium (mg/100g)	8.87^{c} ± 0.006	5.37^{a} ± 0.01	6.85^{b} ± 0.017
Magnesium(mg/100g)	3.57^{c}± 0.01	1.69^{a}± 0.015	2.22^{b}± 0.015
Phosphorus (mg/100g)	56.77^{c} ±0.015	51.97^{a} ±0.01	53.24^{b}± 0.04
Ash (%)	4.75^{a} ±0.05	8.19^{c} ±0.01	6.76^{b} ± 0.03
Protein (%)	20.11^{c} ±0.05	20.03^{a}± 0.017^{a}	20.06^{b} ±0.02
Carbohydrate (%)	45.74^{b} ±0.06	41.8± 0.05	45.74^{b} ±0.06
Moisture Content (%)	9.25^{b} ± 0.03	10.72^{c} ±0.03	2.22^{b}± 0.02
Fat (%)	3.09^{c} ±0.02	2.31^{a} ±0.02	2.76^{b} ± 0.05
Dietary Fibre (%)	17.51^{c} ±0.02	17.35^{a} ± 0.02	17.42^{b} ± 0.03

Samples carrying the same superscripts in the same column are not significantly different at [*p*>0.05]. Values are means of triplicate±SD. **A:** *Pleurotus ostreatus* cultivated on *Pycnanthus ongoleubis*, **B**: *Pleurotu sostreatus* cultivated on *Ceiba pentandra*, **C**: *Pleurotus ostreatus* cultivated on *Cananium* sp.

Amino acid composition of *Pleurotus ostreatus* cultivated on different woody substrates is shown on Table 2. The most abundant amino acids are glutamic acid, arginine, aspartic acid, threonine, leucine and alanine. Chirinang and Intarapichet (2009) had earlier reported that these amino acids are more abundant in *P. ostreatus* and *P. sajor-caju*. However, glutamic acid (9.01g/100g to 10.3 g/100g) was found to be more abundant in *P. ostreatus* cultivated on woody substrate when compared with 5.01 g/100g reported by Chirinang and Intarapichet (2009) for *P. ostreatus* cultivated in Thailand. The possible cause of the differences found in the amino acid composition of this mushroom may be as a result of genetic variation and cultivation process applied in commercial practices. Mendez *et al.* (2005) had earlier reported that genetic variation and cultivation process has a great influence on the nutritional composition of *P.* species. *P. ostreatus* cultivated on *Pycnanthus ongoleubis* had higher and significantly different (P≤0.05) values in all the amino acids when compared with *P. ostreatus* cultivated on the other woody substrates except Phenlyalanine.

Table 2. Amino acid content of *Pleurotus ostreatus* cultivated on different woody substrates

Amino acid content (g/100g)	A	B	C
Alanine	3.75^{c} ±0.01	3.59^{b} ±0.01	3.55^{a} ±0.01
Arginine	6.30c ±0.01	5.79b ±0.01	5.02a±0.02
Aspartic acid	4.30^{c} ±0.01	4.08^{b} ±0.01	3.80^{a}±0.01
Cystine	0.53^{b} ±0.01	0.53^{b} ±0.01	0.46^{a}±0.01
Glutamic acid	10.2^{c} ±0.01	9.91^{b} ±0.01	9.07^{a}±0.01
Glycine	1.65^{c} ±0.01	1.56^{b} ±0.01	0.43^{a}±0.01
Histidine*	1.10^{c} ±0.00	1.10^{b} ±0.01	1.03^{a}±0.01
Isoleucine*	1.26^{c} ±0.12	1.19^{b} ±0.01	1.10^{a}±0.01
Leucine*	2.31^{c} ±0.01	2.17^{b} ±0.00	1.76^{a}±0.01
Lysine*	1.50^{c} ±0.01	1.42^{b} ±0.01	1.40^{a}±0.01
Methionine*	0.53^{c} ±0.01	0.42^{b} ±0.01	0.47^{a}±0.01
Phenylalanine*	1.27^{a} ±0.01	1.44^{b} ±0.00	1.27^{a}±0.01
Proline	0.433^{b} ±0.01	0.42^{a} ±0.01	0.42^{a}±0.01
Serine	2.10^{c} ±0.01	2.05^{b} ±0.00	1.94^{a}±0.00
Threonine*	2.30^{c} ±0.01	2.25^{b} ±0.01	2.08^{a}±0.01
Tyrosine	1.13^{c} ±0.01	0.97^{b} ±0.01	0.81^{a}±0.01
Valine*	1.63^{c} ±0.01	1.60^{b}±0.01	1.42^{a}±0.01
Total amino acid	42.30	40.56	35.97

Samples carrying the same superscripts in the same column are not significantly different at [p>0.05]. Values are means of triplicate±SD. **A:** *Pleurotus ostreatus* cultivated on *Pycnanthus ongoleubis*, **B**: *Pleurotus ostreatus* cultivated on *Ceiba pentandra*, **C**: *Pleurotus ostreatus* cultivated on *Cananium* sp.

In conclusion, this study established the effect of tropical wood substrates on the mineral and proximate composition of *P. ostreatus.* The results revealed that sawdust from *Pycnanthus ongoleubis* showed good potential as substrate for cultivation based on higher and significantly different (P≤0.05) mineral and proximate contents found in *P. ostreatus* cultivated on it. Sawdust from *Pycnanthus ongoleubis* which most sawmill dispose into the environment could be a good substrate for commercial cultivation of *P. ostreatus*.

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