Advances in Research
7(3): 1-6, 2016, Article no.AIR.26196
ISSN: 2348-0394, NLM ID: 101666096

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Nutrient Profile and Phytochemical Analysis of Commercially Cultivated Oyster Mushroom in Calabar, South-South Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors RUBE, UOE and CAE designed the study, wrote the protocol and the first draft of the manuscript. Authors RUBE, CAE, VOU and UOE managed the literature searches, phytochemical and nutrient analyses. Author RUBE identified the species of mushroom and data management and analysis were carried out by author UOE. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AIR/2016/26196
Editor(s):
(1) Marco Trevisan, Faculty of Agricultural Sciences, Institute of Agricultural and Environmental Chemistry, Catholic University of the Sacred Heart, Italy.
Reviewers:
(1) Hasan Hüseyin Doğan, Selcuk University, Turkey.
(2) Eduardo Bernardi, Federal University of Pelotas, Brazil.
Complete Peer review History: http://sciencedomain.org/review-history/14751

Original Research Article

Received 5th April 2016
Accepted 6th May 2016
Published 23rd May 2016

ABSTRACT

The nutrient profile and phytochemical screening of commercially sold edible mushroom in Calabar Metropolis were investigated. The proximate composition revealed the presence of all the different classes of food except ether extract (fat). The oyster mushroom was made of 91.00% moisture and this was the highest followed by protein and carbohydrate with 31.93% and 35.07%, respectively. Mineral analysis showed that nitrogen was the most abundant mineral followed by potassium with values of 5.11% and 0.72% respectively. Vitamin analysis revealed the presence of vitamins A, B, C and E with B being the most abundant while the least abundant vitamin was A. Phytochemical screening of ethanolic and aqueous extracts showed the presence of secondary metabolites such as alkaloid, glycosides, saponin, tannin, flavonoid, reducing compound, polyphenol, but not phlobatannin, anthraquinone and hydroxymethyl anthraquninone. Saponin, polyphenol and reducing compound on quantification were much higher than the rest of the bases with values 4.02, 3.16 and 4.59%, respectively.

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Keywords: Oyster mushroom; phytochemicals; proximate and vitamins.

1. INTRODUCTION

Mushroom is generally defined as the fleshy, spore bearing fruiting body of a fungus that is characteristically produced above ground, on soil or on decomposing wood. It belongs to the order *Boletales* and family *Boletaceae* [1]. There exist about 14,000 to 22,000 kinds of mushroom of which approximately 2,000 to 3,000 are described as edible and 1,400 as poisonous mushrooms [2]. Around the world, three species are the most cultivated and they include button, shiitake and oyster mushrooms in descending order. *Pleurotus* species belong to the phylum Basidiomycota that produce oyster shaped mushroom called basidiocarps and could be coloured or white [3]. Oyster mushroom is well suited for the third world since it can easily be grown on agricultural waste and does not require compositing as a step in its cultivation. Edible mushrooms have been shown to be a rich source of food in terms of nutrients and are also known to possess a number of interesting properties such as antimicrobial, antiviral (including human immunodeficiency virus), antitumor, antineoplastic, hepatoprotective and immunomodulatory [2,3]. Studies have shown that different species of wild edible mushrooms and commercially cultivated mushrooms differ significantly from one another in a number of ways, most especially by way of nutrient composition. A number of studies have shown that nutrient composition is dependent on the type of substrate utilized and the growing conditions [4,5,6] and recently, a study by Ziarati et al. [7] showed that cooking conditions have a profound significant effect on nutrient composition. In Nigeria, especially the south-east and south-south regions, wild edible mushrooms are an important part of diets. In addition to their nutritional and economic values, mushroom is also consumed for its medicinal properties [5]. Despite the fact that a lot is now known about the nutritional content of many wild edible mushrooms around the country, there is serious dearth of information on the nutritional facts of commercially sold oyster mushroom in Calabar and hence the reason for this study.

2. MATERIALS AND METHODS

2.1 Source of Sample and Identification

The oyster mushroom used in this study was obtained from State Agriculture Department in Calabar, Cross River State, Nigeria and was identified at Microbiology Department, Obong University, Obong Ntak, Etim Ekpo Local Government Area, Akwa Ibom State, Nigeria. The Mushroom used in this study was identified as Oyster Mushroom (*Pleurotus ostreatus*).

2.2 Preparation of Sample and Extracts

The sample and the aqueous and ethanolic extracts used in this study were prepared as previously described by Ebana et al. [8] and Ebana et al. [9].

2.3 Phytochemical Screening

The extracts were screened for the presence of phytochemicals as previously described by Ebana et al. [8,9] and Preveena et al. [10] but with some little modifications.

2.4 Test for Tannins

To exactly 1 ml of the mushroom extracts, 2 mls of 5% ferric chloride was added. The formation of a dark blue or greenish black colouration was taken as positive.

2.5 Test for Saponins

Exactly 2 ml of distilled water was added to 2 ml of the aqueous extract and shaken for about 5 to 10 minutes. Formation of about 1 cm layer of permanent froth was regarded as positive.

2.6 Test for Flavonoids

About 1 ml of 2N sodium hydroxide was added to 2 mls of the extracts. The formation of a yellow colour was regarded as positive.

2.7 Test for Alkaloids

About 2 ml of each extracts were stirred with 5 ml of 1% aqueous hydrochloric acid on a steam bath and 1 ml of the filtrates then treated with a few drops of Mayer's reagent and a second 1 ml portion was treated similarly with Dragendorff's reagent. The presence of a precipitate with either of these reagents was taken as positive.

2.8 Test for Glycosides

Exactly 2 ml of chloroform with 10% ammonia solution was added to 2 mls of each of the

extracts. Formation of a pink colour was regarded as positive for glycosides.

2.9 Test for Anthraquinones

About 2 ml of each extracts were shaken with 10 ml of benzene, these were filtered and 5 ml of 10% ammonia solution added to the filtrates and the mixtures stirred. The presence of a pink or red or violet colouration in the lower phase indicated the presence of free anthraquinones.

2.10 Test for Phlobatannins

About 5 mls of each of the extracts were boiled with 1% aqueous hydrochloric acid. Deposition of a red precipitate was taken as positive.

2.11 Test for Hydroxyanthraquinones

A few drops of 5% ammonia were added to about 2 ml of the extracts, the formation of a red colour or precipitate was taken as positive.

2.12 Test for Polyphenols

About 5 ml of each extracts were heated with 10 ml of distilled water for 30 minutes. Then 1 ml mixture of 10% ferric chloride and 1% potassium ferricyanide added to it. The formation of a green blue colour was regarded as positive.

2.13 Quantification of Phytochemicals

2.13.1 Tannin, saponin, alkaloid and flavonoid

Tannin content of the sample was quantified using the Folin Denis Colorimetric method [11]. Saponin was quantified using the double solvent extraction gravimetric method while the alkaline precipitation gravimetric method was used for alkaloid. Flavonoid was quantified using the acid reflux and ethyl acetate method of Harborne [12].

2.13.2 Reducing sugar, glycosides and polyphenol

Reducing sugar was estimated using Benedict's quantitative test and the formular of AOAC [13] Glycoside was estimated using the method described by AOAC [13]. Polyphenol content of the sample was determined using the spectrophotometric method described by Ekwenye and Okorie [14].

2.13.3 Proximate composition analysis

The mushroom sample was analyzed for food composition according to the Association of Analysis Official Analytical Chemists (AOAC) [15]. These included moisture, crude fiber, ash, crude protein, crude fat, and carbohydrate.

2.13.4 Determination of vitamins

Vitamins A, E, B and C were determined according to methods previously described by Bessey et al. [16,17], Bender [18,19] and Ball [20].

2.13.5 Determination of mineral elements

The mineral elements were determined by the dry ash extraction method of AOAC [15] at the Central Laboratory of Faculty of Agriculture, Wildlife and Forestry, University of Calabar, Calabar, Nigeria.

2.14 Data Analysis

Replicate readings obtained were analyzed for significance using Analysis of Variance (ANOVA) at 95% significance level. All the analyses were done using Microsoft Excel 2007 Version.

3. RESULTS

The result of the proximate composition of the studied mushroom is presented in Table 1. The results indicate that the mushroom was very rich in moisture (91.00%). Ether extract (crude lipid) was not detected in the sample. Crude protein was 31.93%, nitrogen free extract (carbohydrate) 35.07%, crude fibre 25.00% and ash 8.00%. The result for the mineral composition of the mushroom is presented in Table 2. The minerals examined were nitrogen, phosphorus, potassium, calcium and magnesium. The most abundant mineral was nitrogen with a composition of 5.11% followed by potassium with 0.72%. The least abundant mineral examined was magnesium with 0.29%. Phosphorus and calcium had roughly equal composition of 0.36% and 0.38%, respectively.

Table 1. Proximate composition *Pleurotus ostreatus*

Parameters	Composition (%)
Crude protein	31.93
Ether extract	0.00
Ash	8.00
Crude fiber	25.00
Nitrogen free extract	35.07
Moisture	91.00

Table 2. Mineral composition *Pleurotus ostreatus*

Minerals	Composition (%)
Nitrogen	5.11
Phosphorus	0.36
Potassium	0.72
Calcium	0.38
Magnesium	0.29

The result of the vitamins analysis is presented in Table 3. Triplicate readings obtained were analyzed using ANOVA and the results presented as Mean±SD. The analysis gave a significant probability value of less than 0.05. Vitamins A, B, C and E gave 38.07 µg/dl, 57.15 mg/dl, 6.28 mg / 100 ml and 1.92 mg/ 100 ml respectively. From the results, the most abundant vitamin was B followed by C and E. The least abundant vitamin was vitamin A (38.07 µg /dl which is equivalent to 0.0381 mg/ 100 ml).

Table 3. Vitamins composition of *Pleurotus ostreatus*

Minerals	Quantity
A (µg/dl)	[a]38.07±0.01
B (mg/dl)	57.15±0.01
C (mg/100 ml)	6.28±0.03
E (mg/100 g)	1.92±0.02

[a]Mean±SD and P value < 0.05 and is significant
mg/dl is equivalent to mg / 100 ml and
1 µg /dl = 0.001 mg/ 100 ml

Furthermore, the results of the phytochemical screening using ethanolic and aqueous extracts are presented in Table 4. The screening reveals that the *Pleurotus ostreatus* is very rich in a variety of phytochemicals such as alkaloids, glycosides, saponins, tannins, flavonoids, reducing compounds and polyphenols. However, phlobatannins, anthraquinones and hydroxymethyl anthraquinones were absent. Polyphenol was present in much excess in aqueous extract and in excess in the ethanolic extract. Saponins, flavonoids and reducing compounds were present in excess in the aqueous extract.

Quantitative estimate of the phytochemical bases is presented in Table 5. Triplicate readings were obtained and analyzed for variance. The analysis indicates that Mean±SD were significant with p values less than 0.05. Reducing compounds gave a value of 4.59±0.01%, saponins 4.02±0.02% and polyphenols 3.16±0.02%. The least abundant base was tannins 0.15±0.01%.

Table 4. Phytochemical screening of *Pleurotus ostreatus*

Phytochemicals	Ethanol extract	Aqueous extract
Alkaloids	+	+
Glycosides	+	+
Saponins	+	++
Tannins	+	+
Flavonoids	+	++
Reducing compounds	++	++
Polyphenol	++	+++
Phlobatannins	-	-
Anthraquinones	-	-
Hydroxymethyl anthraquinones	-	-

Key: + = Present, ++ = Present in excess,
+++ = Present in much excess and - = Absent

Table 5. Crude quantification of phytochemicals *Pleurotus ostreatus*

Phytochemicals (%)	Mean±SD
Alkaloids	0.60±0.10[a]
Glycosides	1.07±0.01
Saponins	4.02±0.02
Tannins	0.15±0.01
Flavonoids	1.20±0.10
Polyphenol	3.16±0.02
Reducing compounds (mg %)	4.59±0.01

[a] Triplicate readings are presented as Mean±SD, P value < 0.05 and significant

Fig. 1. A portion of the studied oyster mushroom

4. DISCUSSION

Proximate composition of the oyster mushroom revealed that it is a rich source of food nutrients

as it contains moisture 91.00 %, carbohydrate 35.07%, protein 31.93%, fiber 25.00, ash 8.00% and fat or ether extract was absent in the Oyster mushroom used in this study. Jonathan et al. [6] reported slightly lower values with *P. ostreatus* grown on different substrates for protein, fiber and carbohydrate. In their study, they found fat with values ranging from 3.93 to 8.72%. Our findings for proximate analysis were more agreeable to that obtained by Ahmed et al. [21]. In addition to the basic classes of food, *P. ostreatus* have been found to contain about eighteen different amino acids [3]. Furthermore, the studied oyster mushroom was analyzed for nitrogen, potassium, calcium, phosphorus and magnesium. Nitrogen was the most abundant of all the minerals examined. Oyster mushroom has been found to contain these minerals and even much more in an earlier study [3]. The vitamins examined were A, B, C and E with vitamin B being the most abundant (57.15 mg/dl) followed by C and E with 6.28 and 1.92 mg/100 g. The least abundant was A 38.07 (µg/d*l*). Jonathan et al. [6] found that *P. ostreatus* grown on different substrates contained vitamins B_1, B_2, B_3 B_5, C, D but not A.

The ethanolic and aqueous extracts of the Oyster mushroom showed that it is rich in number of phytochemical bases such as alkaloids, glycosides, saponins, tannins, flavonoids, reducing compounds and polyphenols. However, the extracts lacked phlobatannins, anthraquninones and hydroxymethyl anthraquinones. The most abundant phytochemicals were polyphenol and reducing compounds. The bioactive agents of *Pleurotus* species have been shown by Akyuz et al. [22] to have excellent antimicrobial activity against simple and multiple drug resistant strains of *Esherichia coli, Staphylococcus epidermidis* and *Staphylococcus aureus.* Triplicate readings obtained from the crude quantification of these phytochemicals gave significant mean±sd values. Saponins, polyphenols and reducing compounds gave values of 4.02±0.02(%), 3.16±0.02% and 4.59±0.01 mg%, respectively.

5. CONCLUSION

Based on the findings in this study, Oyster mushroom is rich in essential minerals, vitamins and other classes of food. Phytochemical screening revealed that it is also abundant with secondary metabolites or phytochemical bases that could be exploited for bioactive compounds. We recommend that further studies should be carried out to ascertain the bio-potentiality of these secondary metabolites.

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:
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