CHEMICAL COMPOSITION OFOYSTER MUSHROOM (*Pleurotuspulmonarius*) CULTIVATED ON DIFFERENT AGRICULTURAL WASTE

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Abstract

The chemical composition of *Pleurotuspulmonarius*mushroom cultivated on different agricultural waste materials was evaluated. The mushroom was cultivated on sawdust, corncobs, cassava peel and sugarcane bagasse and the samples were denoted with SDM, CCM, CPM and SBM, respectively. The different substratesinfluenced the chemical composition of the cultivated mushrooms. The highest protein and fat content were recorded in sample CCM and CPM at 35.69% and 3.44% respectively. Sample SBM had the highest crude fibre and carbohydrate content of 13.87% and 41.67%, respectively. The highest ash content was recorded in sample CCM (12.02%). The result for the mineral composition of the samples showed that potassium and selenium contentshad no significant difference ($p>0.05$) among all samples except for samples SDM and CCM. Copper and magnesium contents showed significant difference ($p<0.05$) in sample SBM. Similarly, iron and calcium contents differed significantly ($p<0.05$) across all the samples. The sodium content significantly differed ($p<0.05$) in sample CPM. Samples SDMandCPM differed significantly ($p<0.05$) from samples CCM and SBM inphosphorus. Samples SDM and CCM significantly differed ($p<0.05$) from samples CPM and SPM inZinc. The cultivation of edible mushrooms on cheap and readily available agricultural waste materials will not only reduce problems of agro-waste disposal but could also help produce nutritious and safe mushrooms thereby reducing the overgrowing problem of protein-energy malnutrition in developing countries.

Keywords: *Pleurotuspulmonarius*, Agro-waste, Mineral composition, Proximate composition

Introduction

Mushroom is the fleshy, spore bearing fruiting body of a fungus. Mushrooms are saprophytes and include members of the Basidiomycota and some members of the Ascomycota. Oyster mushrooms are valuable healthy food, that are low in calories, high in proteins, chitin, fiber and vitamins such as vitamin C, D the B-complex vitamins and minerals (Lee *et al.,* 2018). Mushroom protein appears to be intermediate in nutritional qualities between meat and vegetable proteins (Singh, 2017).Oyster mushroom are found in clusters naturally during the raining season in the wild, they are alsoeasily grown on different lignocellulosic agricultural wastes such as banana leaves, cereal straw, paper wastes, sawdust, rice husk and straw, andsugarcane residues. However, the yield and the quality of oyster mushroom depend on the chemical and nutritional content of substrates (Bhattacharjya*et al.*, 2015).The oyster mushroom (*Pleurotus*species) is the most easily and artificially cultivated and the cultivation has been regarded as the most profitably and environmentally friendly method of recycling agricultural waste which often cause environmental problems with a zero emission.

The interest of oyster mushroom is increasing largely due to its taste, nutrient, and medicinal properties are not often attacked by diseases and pests. Although, several research works had been conducted on the use of different substrates for cultivation of mushroom (Bhattacharjya*et al.,* 2015; Kinge*et al.,* 2016), however, there exist variations in their nutritional composition with different substrates.Most literature focuses more on the yield and there is dearth of information on the proximate and mineral composition of mushroom (*P. pulmonarius*) cultivated on sawdust, cassava peel, sugarcane bagasse and corncob which constituteenvironmental waste in Bida, Niger State. It is opined that this research could give valuable nutritional information on themushroom (*P. pulmonarius*) as well as encourage mushroom farming in household or commercial basis which will hitherto increase consumption and more participation in cultivation of the mushroom and could help address malnutrition in the rural area and reduce food scarcity in the society.

Materials and Methods

Materials

Pleurotuspulmonarius spawns were purchased from LTC Farms Oshobgo, Osun State. The agro- wastes used in this study were sawdust, corn cob cassava peels and sugar bagasse. Sawdust was collected from the local sawmill in Bida, corncob and cassava peels were collected from the local processors. The sugarcane bagasse also was obtained from the local sugarcane juice producer in Bida, Niger State Nigeria. These were then collected in jute bags and transported to the laboratory. All reagents used for this study were of analytical grade.

Preparation of substrates

Twenty kilograms each of the corncob, cassava peel and sugarcane bagasse were cleaned by removing the extraneous particles, followed by pulverization.Essentially,20 kg each of the substrates was added calcium carbonate 1:32g (w/w) and then soaked in waterin the ratio 1:2(w/v), heaped and covered to allow for fermentation process for 7 days, turned for every two days so as enabling the cellulosic breakdown by the effective microorganisms. The substrates were drained and 1kg of each substrate was weighed into 15x30cm of polyethylene bags and these were autoclaved at 121^0C for 15minutes at 15 psi and allowed to cool.

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Mushroom cultivation and processing

The cultivation was carried out using the method described by Ariahu*et al.* (2009) with slight modification.After cooling, the substrates were inoculated with 20g each of*P. pulmonarius* spawn. The inoculated substrates were then transferred toa darkroom where the temperature and relative humidity were maintained between 25-27°C and 80-90% respectively with adequate ventilation. The inoculated bags wereleft for full colonization of the substrate by mycelia.Full ramification was achieved in 55 days. The bags were watered and fruiting bodies of the mushroom (*P. pulmonarius*) developed were harvested. Mushrooms were cleanedand then cut into slices, dried in anair draft-oven (Gallenkamp, Cheshire, UK) at 45°C, until constant moisture content was obtained. The various dried mushroom samples were grinded using an electric grinder and sifted through 500μm screen to obtain mushroom (*P. pulmonarius*) fine powder fromsawdust (SDM), corncob (CCM), cassava peel(CPM), and sugarcane bagasse (SBM). These samples were coded and placedin airtight containersand stored at room temperature.

Methods

Proximate analysis:
Moisture content, protein, fibre, fat and ash contents of mushroom samples were determined using the AOAC (2012) methods. Carbohydrate content was calculated by difference. The difference in value was taken as the percentage total carbohydrate content of the sample.

Mineral analysis:
Sodium and potassium were determined using flame photometer while the levels of calcium, zinc, phosphorus, magnesium, iron, selenium, copper and lead were determined using Atomic Absorption Spectrophotometer (Perkin-Elmer, Analysist A700) after digestion with concentrated nitric acid (AOAC, 2012).

Statistical analysis

The experimental results were expressed as mean ± standard deviation (SD) of three triplicates. Data obtained were analyzed using one way Analysis of variance (ANOVA) using Statistical Packages for Social Scientists (SPSS) version 18. The level of significance was set at0.05 and means separated with Duncan's New Multiple Range Test (DNMRT).

Results and Discussion

Proximate composition of *P. pulmonarius*mushroomcultivated on different substrates

The proximate composition of the various mushroom (*P. pulmonarius)* floursfrom different substrates are presented in Table 1.The moisture content, protein, crude fibre content ranged between 6.52-7.31%, 24.23-32.76%, and 10.73-13.87%, respectively. While the ashand crude fat ranged from 8.13-12.02% and 2.01-3.44%, respectively. The variations in the proximate composition of the samples cultured on different substrates conformedto

previous studies reportedby Bhattacharjya*et al.*(2015); Kinge*et al.*(2016).The protein contents of mushroom depended on biological, chemical differences and the carbon nitrogen ratio of substrate therefore variations in values.The crude protein content of *P. pulmonarius*and crude fiber content are within the range of values of 25.1 to 29.5%and 5.1% to 16.7% as reported by Kinge*et al.* (2016) for oystermushrooms cultivated on corncobs and sawdust. Therefore, *P.pulmonarius* mushroom can be ranked as protein-rich food and also good source of fibre. This could be advantageous composite flour production.
The ash and fat content in this study are within the range7.0 - 9.5% and2.0% - 4.6%reported byKinge*et al.* (2016). A slightly lower ashvalue of 7.52% - 8.54% and higher fat content values 3.89 and 4.32%were reported by Okwulehie*et al.* (2014) for *P. pulmonarius*cultivated on sawdust and *Andropogangayanus*straw.Low carbohydrate content ranging between29.26-41.67% was recorded in all the samples. Mushrooms generally are low in carbohydrate because they are non-photosynthetic, therefore can be recommended in weight loss, diabetic and heart patients (Singh, 2017).
These variations in the chemical composition may be attributed to the differences in the substrate used for cultivation, since the growth performance and nutritional composition of oyster mushrooms depend on the composition of substrate on which they are cultivated (Khare*et al.*, 2010).

Table 1: Proximate composition of mushroom (*P. pulmonarius*) cultivated on different agricultural wastes

Parameters (%)	SDM	Mushroom flours CCM	CPM	SBM
Moisture	$6.52^{d}\pm0.10$	$7.31^{a}\pm0.20$	$7.05^{b}\pm0.10$	$6.98^{c}\pm0.10$
Crude protein	$33.24^{b}\pm0.10$	$35.69^{a}\pm0.15$	$32.76^{c}\pm0.01$	$26.23^{d}\pm0.02$
Crude fibre	$10.73^{d}\pm0.05$	$12.79^{b}\pm0.10$	$11.23^{c}\pm0.10$	$13.87^{a}\pm0.10$
Ash	$9.91^{c}\pm0.10$	$12.02^{a}\pm0.01$	$10.47^{b}\pm0.20$	$8.13^{d}\pm0.00$
Crude fat	$2.01^{d}\pm 0.11$	$2.91^{c}\pm0.10$	$3.44^{a}\pm0.23$	$3.11^{b}\pm0.15$
Carbohydrate	$38.93^{b}\pm 2.33$	$29.26^{d}\pm0.02$	35.05c±0.35	$41.67^{a}\pm0.23$

Values are Means ± Standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly different ($p<0.05$).
SDM= Sawdust cultivated mushroom
CCM= Corncob cultivated mushroom
CPM= Cassava peel cultivated mushroom
SBM= Sugarcane bagasse cultivated mushroom
ND= Not detected

Mineral composition of *P. pulmonarius*mushroom cultivated on different substrates

The mineral composition of the various mushroom (*P. pulmonarius*) floursfrom different substrate are shown in table 2. The potassium content of samples ranged from 61.17-67.77mg/100g with sample SDM having the highest while the sodium ranged from 52.67-57.82mg/100g with sample CPM having the highest value. Mushrooms are high in potassium and low in sodium, consumption of mushrooms can help decrease the risk of high blood pressure and cardiovascular disease. Similarly, sample CPM recorded the highest phosphorus content (147.94mg/100g) which showed no significances (P>0.05) from sample SDM. The highest amount of iron and calcium were observed in samples SBM and CCM with values rangingfrom 30.14-45.95mg/100g and 100.09-140.45mg/100g, respectively. The iron content in thesamplesagrees with Ogundele*et al.* (2014) who reported4.14mg/kg iron content.The zinc content of the samples ranged from 2.72-3.35mg/100g with sample CCM recording the highest value. Samples SDM and CCM showed no significances (p>0.05). The copper and magnesium content of the samples ranged from 0.06-0.24mg/100gand 26.16-28.38mg/100g, respectively. The result for the magnesium agrees with the report of Agomuo*et al.* (2011).Selenium content of samples ranged from 0.04- 0.08mg/100g with sample SDM having the highest value. The values recorded were within the recommended daily intake of 0.06mg and did not exceed the upper intake level of 0.4mg daily of selenium. Sample SBW recorded the highest values for both minerals. There was no trace of lead in any of the mushroom samples. The difference in substrate used showed no significant difference with values obtained which indicate that the four substrates may contain nearly the same mineral content. The result of the current study disagrees with the findings ofOgundele *et al.* (2014) who reported high mineral content in*P. ostreatus*for potassium (885.06mg/kg), zinc (3.08mg/kg), magnesium (65.58mg/kg), and lower calcium (3.04mg/kg) contents cultivated ondifferent sawdust substrates.

Table 2: Mineral composition of mushroom (*P. pulmonarius*) cultivated on different agricultural wastes

Parameters (mg/100g)	SDM	Mushroom flours CCM	CPM	SBM
Potassium	67.77^{a}±0.58	61.71^{b}±0.73	61.29^{b}±0.30	61.17^{b}±0.15
Sodium	54.53^{b}±0.47	52.67^{c}±0.67	57.82^{a}±0.34	53.54^{bc}±0.58
Phosphorus	147.89^{a}±0.58	138.13^{b}±0.99	147.94^{a}±0.56	138.28^{b}±0.24
Iron	40.04^{b}±0.32	37.88^{c}±0.59	30.14^{d}±0.01	45.90^{a}±0.73
Calcium	100.09^{d}±0.23	140.45^{a}±0.56	105.93^{b}±0.57	102.28^{c}±0.56
Zinc	3.32^{a}±0.24	3.35^{a}±0.18	2.72^{b}±0.05	2.79^{b}±0.08
Copper	0.06^{b}±0.01	0.07^{b}±0.00	0.06^{b}±0.01	0.24^{a}±0.01
Magnesium	27.09^{b}±0.57	26.75^{b}±0.42	26.16^{b}±0.24	28.38^{a}±0.59
Selenium	0.08^{a}±0.01	0.04^{b}±0.01	0.07^{a}±0.01	0.07^{a}±0.00
Lead	ND	ND	ND	ND

Values are Means ± Standard deviation of triplicate determinations. Values in the same column with different superscripts are significantly different (p<0.05).

SDM= Sawdust cultivated mushroom
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ND= Not detected

Conclusion

The study demonstrated that cultivation of edible *P. pulmonarius*mushroomon cheap and available agricultural waste materials greatly influenced the chemical composition of the samples. The proximate composition analysis revealed that the fruiting bodies harvested from corncob and sugarcane bagasse substrates hold tremendous promise of nutritious food source that is rich in protein and fibre and therefore recommended.The result for the mineral composition of the fruiting bodies also indicated an excellent source of vital minerals. Absence of lead in the entire mushroom cultivated indicates non-potential health risk for the consumers. Therefore, mushroom farmers should adopt the use of these agro-waste materials for cultivation in order to produce nutrient-dense and safe mushrooms for consumption. Thus, utilization of these agro-wastes; for the production of oyster mushrooms could be more economically and ecologically practical.

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