EVALUATION OF THE NUTRITIONAL COMPOSITION AND PHYTOCHEMICAL SCREENING OF AN EXOTIC AND WILD SPECIES OF OYSTER MUSHROOMS (*Pleurotus-sajor caju*)

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ABSTRACT

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Mushroom is use in the preparation of several delicacies in many part of Nigeria, There is dearths of information on the nutritional qualities of oyster mushroom (Pleurotus sajor caju) cultivated on gmelina wood waste. Hence, this study is designed to ascertain the nutritional composition and phytochemical properties of indigenous wild species of oyster mushroom (Pleurotus sajor caju) and the exotic species that is commercially grown on gmelina wood waste at the Forestry Research Institute in Ibadan, Nigeria. The samples were obtained and analysed for proximate, mineral and phytochemical properties on dry weight basis using standard methods. Results of Proximate analyses of the exotic and wild oyster mushroom samples were: moisture (7.00 and 7.15%), protein (19.30 and 25.24%), crude fat (7.24 and 6.65%), crude fibre (7.47 and 7.05%), total ash (7.13 and 8.25%) and carbohydrate by difference (51.86 and 45.66%) respectively. Qualitative analysis of both samples showed the presence of the following phytochemicals: alkaloid, saponin, tannin, cardiac glycosides and flavonoid. The quantitative analysis of the phytochemical properties of the exotic specie's showed saponin (4.05%), flavonoid (0.06%) tannin (0.27%) cardiac glycosides (0.63%) and alkaloid (10.05%); while, the wild specie showed saponin (3.03%), flavonoid (0.09%), tannin (0.30%) cardiac glycosides (1.45%) and alkaloid (9.64%). Alkaloid seems to be the most predominant phytochemical in the two mushroom species. The values obtained for the predominant minerals content of the exotic sample were: potassium (mg/100g), magnesium (154.75mg/100g), calcium (142.79 mg/100g) and iron (116.90mg/100g); Most of the values were lower compared with the values of the wild counterpart as follow: potassium (665.89mg/100g), magnesium (162.93mg/100g), calcium (147.23mg/100g) and iron (125.61mg/100g). The other minerals for the exotic species ranged from 68.75mg/100g (manganese) to 0.22mg/100g (molybdenum) while, the wild specie ranged from 72.79mg/100g (manganese) to 0.16mg/100g (molybdenum). This study concluded that oyster mushroom grown on gmelina wood waste favourably compared with the wild counterpart and has potential for use as acceptable human food.

Key words: Oyster mushroom, nutritional, phytochemical and gmelina wood waste

INTRODUCTION

Mushrooms represent one of the world's greatest untapped resources of nutritious food. Presently mushrooms are regarded as a macro-fungus with a distinctive fruiting body which can be either epigeous or hypogeous and large enough to be seen with the naked eyes and could be picked by hand (Chang and Miles, 1992), only fruiting body of the mushroom can be seen whereas the rest of the mushroom remains underground as mycelium. Macrofungi have been used as a valuable food source and as traditional medicines around the world, especially in Japan and China (Akinyele *et al*., 2011) Many health promoting substances e.g. antimicrobial, anticancer, antioxidant, cholesterol lowering property and immunostimulatory effects have been documented for some species of mushrooms (Barros *et al*., 2007; Akinyele *et al*., 2011). Cultivation of saprophytic edible mushrooms may be the only currently economical biotechnology for lignocellulose organic waste recycling that combines the production of protein rich food with the reduction of environmental pollution (Obodai *et al.*, 2003). Oyster (*Pleurotus sajor caju*) mushrooms possess unique nutritional and medicinal values, characteristic aroma and taste. It is a saprophyte that acts as a primary decomposer of woods especially deciduous trees, particularly beech (Philips and Roger, 2006). *Pleurotus tuber regium* is one of the species commonly eaten in the western to the southern parts of Nigeria. Stamets (2001) observed that the fungus is often found growing around the African breadfruit (*Treculia africana*).

Edible mushrooms like *Agaricus sp* and *Pleurotus oastreatus* are commercially produced and sold in markets in Asia, America and Europe. In Nigeria, indigenous mushroom are still hunted for in forests and farmland for sale. The need for commercial production of all edible mushrooms in Nigeria cannot be over emphasized in view of its potential contribution to agricultural production and as a source of cheap protein. Nigeria is richly endowed with good quality mushroom like *Pleurotus* and *Agaricus* genera. The use of local agricultural waste materials to grow

mushrooms seems gaining the interest of some farmers in Nigerian. The protein content of mushrooms depends on the composition of the substratum, size of pileus, harvest time and species of mushrooms (Bano and Rajarathnam, 1982). Most authors reported the digestibility of mushroom protein to be as high as 72 to 83% (Aletor, 1995; Alofe *et al.* 1995; Fasidi and Kadiri, 1990; Florezak and Lasota, 1995; Chang and Boswells, 1996). The digestibility of *Pleurotus* mushrooms proteins is found to be comparable with plant proteins (90%) whereas that of meat is 99% (Bano and Rajarathnam, 1988). The protein is superior to most fruits and vegetables with exception of beans and peas (Bano and Rajarathnam, 1988). According to (Singh and Chaube, 1995) the protein content of edible mushrooms on dry weight basis include *Pleurotus ostreatus* (27.4%), *Pleurotus florida* (37.19%), *Pleurotus sajor-caju* (36.94%) also Ouzouni *et al.* (2009) reported that in general, the fruiting bodies of mushrooms contain about 56.8% carbohydrate, 25.0% protein, 5.7% fat and 12.5% ash on a dry weight basis. The carbohydrate content of mushrooms represents the bulk of fruiting bodies accounting for about 50 to 65% on dry weight basis. Free sugars amounts to about 11%. Florezak *et al*. (2004) reported that *Coprinus armamentariums* contain 24% carbohydrate. On dry matter basis; the total fat content of *Agaricus bisporus* was reported to be 1.66 to 2.2/100g (Mattila *et al;* 2001). Kanwar *et al;* (1990) reported a fat content of 11.52% in the *Amanita ceasarea* fruiting bodies. Mushrooms are considered good source of fats, soluble and insoluble fiber, beta-glucans, chitin, phenolic compounds and ribonuclease (Silva *et al.,* 2002; Ngai and Ng, 2004). The fruiting bodies of mushrooms are characterized by high level of well assimilated mineral elements. Major mineral constituents in mushrooms are potassium, phosphorous, sodium, calcium and manganese, while copper, zinc and iron form parts of the minor constituents (Bano and Rajarathanum, 1988 and Chang, 1996). Potassium, phosphorus, sodium and manganese constitute about 56 to 70% of the total ash content of the mushrooms (Chang, 1996) while potassium alone forms 45% of the total ash. Mushrooms have been found to accumulate heavy metals like cadmium, lead, arsenic, copper, nickel, silver, chromium and mercury. The mineral proportions vary according to the species, age and the diameter of the fruiting body. It also depends upon the type of the substratum (Aletor, 1995). The mineral content of wild edible mushrooms has been found higher than cultivated ones (Aletor, 1995; Mattilla *et al.,* 2001).

The objective of this study was to determine the proximate composition, phytochemical properties and mineral components of the indigenous wild species of oyster mushroom and the exotic species commercially grown on *gmelina* wood waste as substrate at the Forestry Research Institute, Ibadan, Nigeria.

MATERIALS AND METHODS

Source of sample

Five hundred grams of the exotic species of oyster mushroom (*Pleurotus sajor caju*) grown for commercial purpose was purchased at the Forestry Research Institute, Oyo state in Ibadan, Nigeria. The wild specie was purchased in Aduratedo-Appe; a village in Kabba/Bunu Local Government Area of Kogi State, Nigeria. The samples were collected in alluminium foil and then dried in the oven at 60^0C. The samples were ground to powder with the use of mortar and pestle in the food processing laboratory of the department of Home Economics and Food Science, University of Ilorin, Nigeria.

Proximate analysis

The ground oyster mushroom material was used to carry out proximate analysis using standard method of AOAC (2000) for dry matter, total ash, crude fat, crude fibre and crude protein constituent using nitrogen to protein conversion factor of 6.25. Carbohydrate was determined by difference (AOAC, 2000; Raghuramulu *et al.,* 2003). Minerals were determined from the ash solution as described by AOAC (2000) using Atomic Absorption Spectrophotometer (AAS).

Quantitative screening of anti-nutritional components

The Anti-nutritional component of oyster mushroom were determined using standard procedures (Sofowora, 1982; Trease and Evans, 1983; Sofowora, 1993)

Test for saponin

Two grams of sample were weighed in a beaker; 5ml of distilled water was added and heated to boil. Persisted foaming on warming was taken as an evidence for the presence of saponin.

Test for tannin

Two grams of sample were weighed and mixed with 10ml of distilled water. The mixtures were filtered and two drops of 5% ferric chloride ($FeCl_3$) were added to filtrate. Blue-black was taken as an indication of the presence of tannins.

Test for alkaloid

Two grams of sample were weighed in a beaker and it was extracted with 10ml of 2% hydrochloric acid (HCl) by heating gently for about 5minutes. The HCl extract was filtered with Whatman No.1 filter paper to have a clear solution and prevent false result; 2.5ml of the filtrate was treated with few drops of Dragendoff's reagent. Appearance of precipitate indicated the presence of alkaloid in the extract.

Test for Cardiac glycosides

Two grams of sample were dissolved in 2ml of glacial acetic acid containing one drop of ferric chloride ($FeCl_3$). The solution was underplayed with 1.0ml of concentrated sulphuric acid (H_2SO_4). A reddish brown colour at the interface indicated the presence of a steroidal ring, that is, a glycone portion of the cardiac glycosides (Keller-Killiani's test).

Test for Flavonoid

Five milliliters of the diluted ammonia solution were added to a portion of aqueous filtrate of sample extract followed by the addition of concentrated sulphuric acid formation of yellow color.

Quantitative assay of anti-nutritional components

The Anti-nutritional component of the mushroom samples was determined using the methods stated by Bohm and Kocipal Abyaza, 1994.

Estimation of Flavonoid

Two grams of the sample (W) were extracted repeatedly with 20ml of 80% aqueous methanol at room temperature for 2hours. The whole solution were filtered using Whatman No.1 filter paper, the filtrate was then transferred into a petri-dish that has been washed, oven dried, cooled in a desiccator and weighed (W_1) and evaporated into dryness in moisture oven and weighed to a constant weight (W_2). The total flavonoid content was determined using as given below.

$$\text{Flavonoid (\%)} = \frac{W_2 - W_1 \times 100}{W}$$

Estimation of Saponin

Two grams of the sample (W) were weighed and 30ml of 20% aqueous methanol was added. It was heated over a hot water bath for 4hours with continuous stirring at about 55^0C. The mixture was filtered and the residue was washed with 20% ethanol two times, the combined extract was reduced to 5ml of its original volume over water bath at 90^0C. Five millilitres of petroleum spirit was added in a separating funnel and ether layer was discarded. Six millilitres of butanol were added to the aqueous layer at the bottom of the funnel and it was washed with 10ml of 5% sodium chloride, A petri-dish that was washed, oven dried and weighed (W_1) before the butanol layer was then poured into it and was weighed (W_2). The saponin content was calculated using the formular.

$$\text{Saponin (\%)} = \frac{W_2 - W_1 \times 100}{W}$$

Estimation of Alkaloids

One gram of the sample (W) was weighed into 50ml of 10% Acetic acid and ethanol. It was mixed by shaking and allowed to stand for 4hours. It was then filtered and the filtrate was evaporated to one quarter its original volume. Concentrated ammonia was added drop wise to precipitate the alkaloid; the precipitate was then filtered into a pre-weighed filter paper (W_1) and washed with 1% NH_4OH. The precipitate on the filter paper was dried in an oven at 60^0C for 30minutes and the filter paper was cooled and weighed (W_2).

$$\text{Calculation: Alkaloid (\%)} = \frac{W_2 - W_1 \times 100}{W}$$

RESULTS

The result in Table1 shows the proximate composition of the wild oyster mushroom (*pleurotus sajor-caju*) and the exotic species that is commercially grown on gmelina wood waste at Forestry Research Institute in Ibadan town. The proximate analysis of both exotic and wild oyster mushroom samples revealed residual moisture content (7.00 and 7.15%), protein (19.30 and 25.24%), crude fat (7.24 and 6.65%), crude fibre (7.47 and 7.05%), total ash (7.13 and 8.25%) and carbohydrate by difference (51.86 and 45.66%) on dry weight basis respectively. Table 3 shows the anti-nutritional component of the wild oyster mushroom specie and the exotic specie that was grown on gmelina wood waste. It is observed from the result that alkaloid is the predominant anti-nutrient followed by saponin and cardiac glycosides. The quantitative analysis of the phytochemical properties of the exotic species showed saponin (4.05%), flavonoid (0.06%) tannin (0.27%) cardiac glycosides (0.63%) and alkaloid (10.05%); while, the wild specie showed saponin (3.03%), flavonoid (0.09%), tannin (0.30%) cardiac glycosides (1.45%) and alkaloid (9.64%). Alkaloid seems to be the most predominant phytochemical in the two mushroom species as obtained in the values of the phytochemicals recorded in Table 3.

The result of mineral analysis (Table 2) shows the mineral composition of the oyster mushroom (*Pleurotus sajor-caju*). The values recorded for major macro elements that are of nutritional importance in the exotic oyster mushroom sample include: potassium (mg/100g), magnesium (154.75mg/100g), calcium (142.79 mg/100g) and iron (116.90mg/100g); these values were lower compared with the values of the wild counterpart as follow: potassium (665.89mg/100g), magnesium (162.93mg/100g), calcium (147.23mg/100g) and iron (125.61mg/100g). The other minerals for the exotic species ranged from 68.75mg/100g (manganese) to 0.22mg/100g (molybdenum) while, the wild specie ranged from 72.79mg/100g (manganese) to 0.16mg/100g (molybdenum).

DISCUSSION

The result obtained from the biochemical analysis carried out on the exotic oyster mushroom specie in this study confirmed that the crude protein, crude fat, carbohydrates and total ash contents were found to be altered by the substrate used for culturing the mushroom as previously reported in a number of study (Humfeld and Sugihara, 1949; Block *et al.*, 1953). The slightly lower values of crude protein content of the exotic sample (19.30%) compared with the wild species (25.24%) may be attributed to the composition of the substratum, size of pileus, harvest time and species of mushrooms (Bano and Rajarathnam, 1982). Most mushrooms obtained from literature had their protein content ranging from 19 to 39g/100g on dry matter basis. The carbohydrate content of mushrooms has been said to represents the bulk of fruiting bodies accounting for 50 to 65% on dry weight basis. The carbohydrate content of the exotic sample (51.86%) and the amount of lipids (7.24%) may as well contribute to its acceptability. The higher level of total ash (8.25%) of the indigenous wild species may be attributed to the higher levels of total mineral content obtained in the sample compared with the exotic counterpart (Tables 4 and 5). Aletor (1995) and Mattilla *et al.* (2001) reported higher mineral content in the wild edible mushrooms than cultivated ones. Mushrooms have been found to accumulate heavy metals (Svoboda *et al*., 2001; Issilogglu *et al.*, 2001; Malinowska, 2004). Minerals are essential for the growth, development, maintenance and repair of the body, the result of the minerals that were analysed shows that both exotic and wild oyster mushroom samples contain essential minerals that are essential constituents of skeletal structures such as bones and teeth. These minerals could play a key role in the maintenance of osmotic pressure, and thus regulate the exchange of water and solutes within the body, helps transmission of nerve impulses and muscle contraction and play a vital role in the acid-base equilibrium of the body thus regulate the pH of the blood and other body fluids. Heavy metal contents of the samples were at relatively lower concentrations; which may make the mushrooms safe for consumption in accordance with the permissible tolerance limits of the estimated toxic metals, also the result revealed that the samples are good sources of potassium (needed for glycogen and protein synthesis, and the metabolic breakdown of glucose), magnesium (activate various key enzyme systems, like kinases and is an essential component of bone, cartilage and the crustacean exoskeleton), iron (essential in transportation of oxygen and electron within the body), calcium (essential for absorption of vitamin B_{12} from the gastro-intestinal tract) and phosphorous (important component of phospholipids, nucleic acids and many key enzymes which play important role in energy and cell metabolism). Sodium is relatively minimal in the samples thus may be good for patients with hypertension, mushroom are said to be good biological accumulators of zinc, and zinc is biologically very vital to the human body. From the values obtained, the samples could be a good source of zinc for human's need. Another mineral element found in the samples is copper which is believed to be necessary for the formation of the pigment melanin, bone and connective tissue, maintenance of the integrity of the myelin sheath of nerve fibers and consequently skin pigmentation. Mushrooms are known for bioconversion of selenium from the growth substrate in its inorganic form to organic form; this mineral is available in trace amount in the body and may helps in fighting against cancer.

Results of quantitative analysis of the anti-nutrients include saponin that have been shown to lower plasma glucose, insulin and (or) plasma cholesterol and triacylglycerols (Slavin *et al*., 1999). Alkaloid has a wide range of biological activities which have been reported as emetic, anti-cholinergic, anti-tumor, diuretic, sympathomimetic, anti-viral, anti-hypertensive, hypnoanalgesic, anti-depressant, miorelaxant, anti-tussigen, anti-microbial and anti-inflammatory. The presence of flavonoids in the mushroom samples may act a little bit like estrogen; which is a hormone that could affect the risk of breast cancer that partly depends on estrogen for its growth.

CONCLUSION AND RECOMMENDATION

The study showed that the exotic oyster mushroom has slightly reduced crude protein, macro mineral composition and few heavy metals with a decreased total ash. The phyto-chemicals composition of the exotic oyster mushroom favorably compared with the indigenous wild species that was analyzed. From the values obtained for all the parameters determined on the exotic species, it can be concluded that oyster mushroom grown on gmelina wood waste could compare favourably with the Nigeria indigenous wild counterpart on the nutritional, phyto-chemical and mineral composition; thus the exotic species has great potential for use as acceptable human food. This study also recommends an improvement on the substratum used for cultivation in order to minimize reduction in the entire composition of the essential macro nutrients present in the exotic species during cultivation.

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Table 1: Proximate composition of Oyster mushroom (*Pleurotus Sajor-caju*)

	Values obtained (%)	
Parameters	Exotic	Wild
Moisture	7.00	7.15
Crude fat	7.24	6.65
Crude protein	19.30	25.24
Crude fibre	7.47	7.05
Carbohydrate	51.86	45.66
Total ash	7.13	8.25

Values are mean of three replicate determinations.

Table 2: Qualitative assay of phytochemical components of exotic and wild Oyster mushroom (*Pleurotus Sajor-caju*) species

	Qualitative score	
Anti-nutrients	Exotic	Wild
Alkaloid	+++	+++
Saponin	+++	+++
Cardiac glycosides	++	+++
Tannin	+	++
Flavonoid	+	++
Antraquinones	NP	NP

Table 3: Quantitative analysis of phytochemical component of exotic and wild oyster mushroom

	Qualitative score (%)	
Anti-nutrients	Exotic	Wild
Alkaloid	10.5	9.64
Saponin	4.05	3.03
Cardiac glycosides	0.63	1.45
Tannin	0.27	0.30
Flavonoid	0.06	0.09
Antraquinones	ND	ND

+ = Degree of Availability; NP = Not present; ND = Not determined

Table 4: Macro mineral composition of oyster mushroom (*Pleurotus Sajor-caju*) species

	Values obtained (mg/100g)	
Macro minerals	Exotic specie	Wild specie
Calcium	142.79	147.23
Magnesium	154.75	162.93
Potassium	636.33	665.89
Sodium	34.48	25.25
Phosphorus	13.02	16.47
Iron	116.90	125.61

Values are mean of duplicate

Table 5: Trace mineral composition of Oyster mushroom (*Pleurotus Sajor-caju*) species

	Values obtained (mg/100g)	
Micro minerals	Exotic specie	Wild specie
Selenium	0.32	0.56
Copper	17.63	10.18
Cobalt	6.82	6.97
Zinc	23.60	23.65
Nickel	2.69	2.10
Molybdenum	0.22	0.16
Manganese	68.75	72.79

Values are mean of duplicate