CHEMICAL COMPOSITION, FUNCTIONAL PROPERTIES AND PROTEIN FRACTIONATION OF EDIBLE OYSTER MUSHROOM (*PLEUROTUS OSTREATUS*)

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Abstract
The edible mushroom (Plueotus ostreatus) was purchased from the local farmer at Akure, Nigeria and was evaluated for proximate composition, minerals, functional properties and the protein fractionation were carried out on edible oyster mushroom (Pleutrotus ostreatus). The mushroom was separated into three parts; Cap, Stalk and the mixture i.e. cap + stalk dried and ground into powder. The various parts were then analyzed. The results show that the stalk had the highest moisture content of 6.33%, cap had the least moisture content of 3.48%. There was noticeable difference in their protein content; 34.19% cap, 20.96% stalk, and 30.48% cap + stalk. The ash content was between 5.30 - 8.24%, fat content were 1.48%, 1.5%, and 1.55% for stalk, stalk and cap, and cap respectively. Crude fibre of the cap, stalk and stalk and cap were 3.14%, 7.53% and 8.12% respectively. Carbohydrate content range between 51.94- 61.77%. water absorption capacity of the cap, stalk, and cap + stalk were 487%, 675% and 530% respectively while oil absorption capacity were within the range of 290 – 330% the bulk density varied as; 0.483g/ml cap, 0.297g/ml stalk and 0.501g/ml cap + stalk. Cap had the highest emulsion and foaming capacity of 17.33% and 30.67% respectively. Phosphorus, magnesium and potassium were the major abundant minerals in mushroom with 497.35mg/100g in cap, 340.59mg/100g stalk and 466.24mg/100g cap and stalk. Protein fractionation revealed that Globulin had the highest proportion with 47.31% cap, 23.31% stalk and 44.65% cap and stalk, while Albumin varied between 3.29 – 4.18 % in cap, stalk and cap + stalk. Edible mushroom may be used as a thickener and flavor enhancer foods in some food production.

Keywords: Functional, fractionation, mushroom, thickener, enhancer

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1. INTRODUCTION

Among the heterotrophic organisms, fungi have a fundamental role in the biological world. They are responsible for the degradation and transformation of plant and animal substances of the forest ecosystem. Through a symbiotic root relationship, fungi are also responsible for the mineral nutrition of plants, attributing to the more important members of the forest ecosystem. In addition, many fungal cells store glycogen, a typical animal polysaccharide. The situation is further complicated by the occurrence of some groups of fungi that form creeping amoeboid cells and also flagellated and mobile zoospores, both characteristics of animals, but which are transformed into fruiting bodies typical of many fungi. Mushroom is a simple form of plant life known as fungus. It is composed of two portions. The above ground portion consisting of a cap and stalk forms the edible portion. On the underside of the cap are found numerous, thin, radiating folds or gills which when nature produce and liberate numerous microscopic reproductive bodies or spores similar in function as seeds in higher plants. The underground root like portion of the mushroom grows extensively in the substratum before the above ground edible portion is formed. It consists of a white cotton thread like growth called the mycelium which permeates the organic matter to obtain nutrients like the roots of higher plant. Mushrooms belong to the kingdom of fungi as earlier mentioned, of the class *Basidiomycetes* and order *Agaricales*. Mushrooms are widely distributed in nature and occur in a variety of habits (Kurzman and

Zadrazil, 1982). They are found in temperature, tropical, shady, woody, and well lighted habitats (Quimio, 1986). Mushrooms produce very buoyant growth during fall in temperate regions (Nout and Keya, 1983; Quimio, 1986; Okhuoya *et al*., 1998). Many species of mushrooms are edible, some are poisonous while others are neither edible nor poisonous (Quimio, 1986). Mushrooms do not possess chlorophyll like green plants for manufacturing their foods. For their growth and development they require preformed foods like cellulose, glucose and starch which are broken down to smaller molecules by the numerous enzymes they possess (Chang, 1984; Zadrazil and Kurtzman, 1982). Mushrooms have preference for specific substrates some are wood-inhabiting; some grow on dead leaves (*folicolus*) while some grow on dung (Coprophilous Quimio, 1986). Oyster mushroom i.e. *pleurotus species* is a tropical and subtropical edible mushroom known to grow on wood, wood shavings, sawdust and various other substrates (Quimio *et al.,* 1990 and Qkhuoya *et al.,* 2000).

Pleurotus is one of the choice of edible mushrooms which can be cultivated in the tropics. Oyster mushroom (*Pleurotus ostreatus*) which is the major edible mushroom, in China it is called the abalone mushroom; several other species are now available for cultivation. These are *pleurotus Sajor-Caju, pleurotus florida, P. Sapidus, p. eryngii, P. columbinus, P. cornucopiae*, and *P. flabellatus.*

Mankind has harvested edible mushroom for millennia. The mushroom were either eaten directly or preserved for later use by drying. Mushrooms were treated as a special kind of food since earliest times.

Nowadays, the migration of many millions of people with different food habits has spread the popularity of mushrooms. (Peter Oei, 2003). Much less controversial is the consumption of mushrooms as a food. Though a lot of mushrooms are consumed in Nigeria there are limited information on their nutritional composition and distribution in the plant as well as their functional properties which are essential in order to fully exploit the full potential of the plant and add more value to it.

The aim and objectives of this research work are to: determine the proximate composition, the nutritionally important minerals, functional properties and the fractionation of protein in edible mushroom.

2. MATERIALS AND METHOD

Materials

The edible mushroom (*Plueotus ostreatus*) was purchased from the local farmer at Akure, Nigeria.

Processing of fresh edible mushroom to powdery form

Drying:This is one of the oldest and most widely used methods of food preservation and it remains the commonest. (FAO, 1985) there are different drying methods used for food preservation, which include sun drying, oven drying which was the method chosen in this practical work and other high technology drying systems. The fresh mushroom (*Pleurotus ostreatus*) was obtained from a farm at Ibadan.

The mushroom samples were sorted by hand; trimmed using a stainless knife and cleansed very well. They were separated into caps, stalks and the mixture i.e. caps plus stalks and then cut into uniform sizes of about 4 cm diameter and 3cm long for cap and stalk respectively. This is just to facilitate the drying. The caps, stalk and the whole mushroom were dried separately as the cap dried faster than both the stalk and the whole using the air oven method. The drying was carried out at 65^{o}C into which the samples were taken hourly, weighed and returned into the dryer until three consecutive identical weights of sample were obtained for almost five hours.

After drying, the mixture at the same ratio (cap plus stalk) were milled separately into mushroom powder and sieved to pass through 250 µm sieve. The mushroom powder obtained was packaged in a polyethylene bags and use for the proximate analysis (Krugliakova, 1990).

Chemical analysis

Proximate composition: The moisture, ash, crude fiber and fat (ether extract) contents were determined using a standard method (AOAC, 2005). Nitrogen content was determined using micro- kjeldahl and converted to crude protein (N x 6.25) (AOAC, 2005). Meanwhile the carbohydrate content was calculated by difference. Determination of Mineral Content: The Iron content was measured colorimetrically at 480nm. For the calcium content, the reading of concentration was done on a spectrophotometer (AAS) while the method used for sodium content determination was flame photometric. The zinc and Phosphorus contents were also determined. All these parameters were determined according to the method of (AOAC, 2005).

Determination of Functional Properties: The Water and Oil absorption capacity were determined according to the method of Sathe *et al.,* (1982), emulsion capacity was determined as described by Hill, (1986), foaming capacity and stability were determined as described by Maeda *et al.,* (1991). The result was expressed as a percentage of water absorbed by the blends on % g/g basis. (Density of water was assumed to be 1 g/ml). The procedure of (Fellows, (2000) was used to determine bulk density. The procedure of AOAC, (1984) was used to determine the fractionation of protein into prolamin, albumin, globulin and gluten.

3. RESULTS AND DISCUSSION

The proximate composition of the edible mushroom powder Table 1 showed that the moisture content reduced from its initial moisture content to 3.48%, 6.33% and 4.81% in cap, stalk and the mixture of both cap and stalk respectively. The low moisture content in the cap of the mushroom could be due to their thin layers which get dry faster than the stem or the mixture. The cap of the mushroom had the highest percentage ash content of 8.2% which was slightly higher than 6.4 – 6.7% reported for *Sajorcaju spp* (Chang *et al.,* 1981). This could be due to genetic factor, soil condition and other environmental factors while stalk and the mixture (cap and stalk) had 5.30% and 6.58% respectively which are still within the range. Mushrooms are often referred to as valuable protein sources. The result indicated that crude protein content of that of cap, stalk and the mixture (cap and stalk) are 34.19%, 20.96% and 30.48% respectively.

The highest protein is from the cap (34.19%), the result is still within the range of 8.9 to 38.7% as reported for *Pleurotus* mushrooms by Bano and Ramarathan, (1982). The fat content of the edible mushroom were 1.60% , 1.50% and 1.50% for the cap, stalk and the mixture (cap and stalk) respectively which are still within the value of 1 – 8% reported by Oei, (2003).

Table 1: Proximate composition of edible mushroom (*Pleurotus ostreatus*) dry basis

Components	Cap	Stalk	Cap+ Stalk
Moisture (%)	3.50±0.65	6.30±0.09	4.80±0.59
Protein (%)	34.20±0.18	21.00±0.30	30.50±0.44
Ash (%)	8.20±0.48	5.30±0.89	6.60±0.45
Fat (%)	1.60±0.21	1.50±0.05	1.50±0.10
Crude Fibre (%)	30.10±0.54	7.50±0.43	8.20±0.77
Carbohydrate (%)	52.9±0.55	61.80±0.12	51.9±0.25

Values in the table are means ± SD from the mean (n=3)

Table 2: Functional properties of edible mushroom (*Pleurotus ostreatus*)

Properties	Cap	Stalk	Cap + Stalk
Water absorption Capacity (g/g)	4.90±0.09	6.80±0.20	5.30±0.14
Oil absorption Capacity (g/g)	3.20±0.08	2.90±0.28	3.30±0.04
Bulk Density (g/ml)	0.50±0.04	0.30±0.03	0.50±0.02
Emulsion capacity (%)	17.30±0.94	5.30±0.47	9.50±0.41
Foaming capacity (%)	30.70±0.94	9.30±0.94	20.7±0.94

Values in the table are means ± SD (n=3)

The crude fibre for each part of the edible mushroom was also varied; 3.1%, 7.5% and 8.1% for the cap, stalk and the mixture, the high percentage of this crude fibre was in the mixture (cap + stalk) which could be due to the presence of cellulose stem which has been reported to increase with maturity of the mushroom (FAO, 1990). the consumption of the stalk or the whole mushroom may be recommended as a good source of dietary fibre. Carbohydrate constitutes the main component of the edible mushroom as indicated in table 1; cap with 52.9%, stalk with 61.8% and the mixture with 51.9%. This is slightly higher than the value of 39.0 to 50.7% reported by Chang *et al.*, (1981) for *Pleurotus* mushroom in China. This could be due to the large range of compounds such as pentoses, hexoses and polymeric carbohydrates including glycogen which serve as an energy storage compound which is concentrated in the stalk, Crisan and Sands, (1978).

Functional properties

The result of the functional properties of the edible mushroom (*Pleurotus ostreatus*) as presented in Table 2 shows the water absorption capacity of the cap, stalk and the mixture (cap and stalk) was: 487%, 675% and 530% respectively. The high water absorption capacity in stalk might be due to the amino sugars and aggregated protein structure. (Hall,1996.) The edible mushroom would be useful in enhancing the thickening capacity of soup and gravies. There is a relationship between the content of hydrophilic of protein and water absorption capacity which means that the edible mushroom powder being rich in protein might have hydrophilic groups exposed to water (Hall *et al.*, 1996). The oil absorption capacity of 318%, 294%, and 330% for cap, stalk and the mixture (cap and stalk) was slated respectively. The high value of the oil absorption capacity of these samples could be due to the stability of the hydrophobic and peptide groups of the protein present in them. It can be used as flavour render in food system. This liquid retention is an index of the ability of the mushroom to absorb and retain oil, which in turn influences the texture and mouth feel of foods (Oei, 2003). The bulk density of the edible mushroom was 0.48g/ml, 0.3g/ml and 0.5g/ml for the cap, stalk and mixture i.e. (cap + stalk) respectively, from the result, it was observed that the mixture (cap and stalk) had the highest value which could be from the textural characteristic of edible mushroom powder, since bulk density of powders depend on the size of the dried particles which is determined by the nature and the composition of the food and the drying conditions. As reported by Fellow, (2000) The low fat content of edible mushroom particularly the cap and stalk (mixture) which form free flowing aggregates, in which there are relatively few points of contact which as tremendously contributed to the high bulk density (Lewis. 1996). The emulsion capacity obtained showed that high percentage of emulsion capacity in the cap could be due to its protein solubility, protein concentration and drying period. The mushroom could be used in combination with other food sample with low emulsion capacity such as wheat flour which range between 7 – 11% as reported by Hall, *et al.*, (1996) and some food emulsions. Foaming capacity as being a very good properties which must be considered in a proteinous food. From table 2 above, cap had 30.67% (FC), stalk had 9.30% (FC) and 20.67% the for the mixture i.e (cap and stalk). It is observed that the cap had the highest (FC) which could be due to the high protein content in it which has ability for gas encapsulation (formability). Hall *et al.*, (1996).

Table 3: Mineral composition of edible mushroom (*Pleurotus ostreatus*) (mg/100g)

Elements (mg/100g)	Cap	Stalk	Cap+Stalk
Sodium (Na)	0.106	32.922	40.642
Calcium (Ca)	0.308	0.637	1.289
Potassium (K)	170.290	225.320	41.803
Magnesium (Mg)	32.135	20.691	26.061
Copper (Cu)	1.606	0.824	0.250
Zinc (Zn)	ND	3.756	9.582
Iron (Fe)	ND	ND	ND
Lead (Pb)	ND	ND	ND
Aluminium (Al)	ND	ND	ND
Phosphorus (P)	497.347	340.590	466.236

ND = Not Detected

Mineral composition

The mineral composition of the edible mushroom is presented in table 3. Mushroom as one of the vegetables is a good source of minerals. From the result above it could be deduced that the high ash content in cap indicates that the edible mushroom (cap) is rich in some mineral elements. Potassium and phosphorus are the main constituents of the ash of *Pleurotus spp*. (Bano and Rajarathnam, 1982) made similar observation 497.347 (mg/100g) cap, 340.590 (mg/100g) stalk and 466.236 (mg/100g) cap + stalk. The mineral composition reported here higher than those reported for some other vegetables such as, *Amaranthus spp*. (190mg/ 100g), bitter leaf (41mg/100g) (Oguntona, 1998). They can supply a good proportion of the recommended daily dietary needs, since the mushroom contain more than the recommended dietary allowance (FAO 1990).

Protein fractionation

Figure 1 showed protein fractionation from edible mushroom (*Pleurotus ostreatus*), globulin was the most abundant protein fraction of (47.31%) cap and (44.65%) in cap+stalk mixture, followed by prolamin (30.28%) in cap and (44.65%) in cap+stalk mixture, glutelin of (6.40%) and (6.26%) in cap and cap+stalk respectively and lastly albumin, while there were some residual protein which were not detected. According to Sathe and Salunkghe, 1981. Globulin is the main protein fraction in common proteinous food such as soybean, whereas albumin has the highest proportion in some seeds such as ebony seeds etc (Hall *et al*., 1996).

4. CONCLUSIONS

In this study, it could be concluded that the production of good quality edible mushroom (*Pleurotus ostreatus*) powder by drying the cap, stalk and the mixture (cap + stalk) separately had really helped us to know the nutritional distribution in the mushroom. It contains high protein and moderate ash content, which serve as a good source of nutrient to human body. From the proximate analysis of *Pleurotus ostreatus* edible mushroom powder containing a reasonable amount of protein most especially in the cap. This could be utilized in the formulation and fortification of our starchy staple or low proteineous foods. The functional properties showed that it can be used as a thickener and flavour enhancer in the food system.

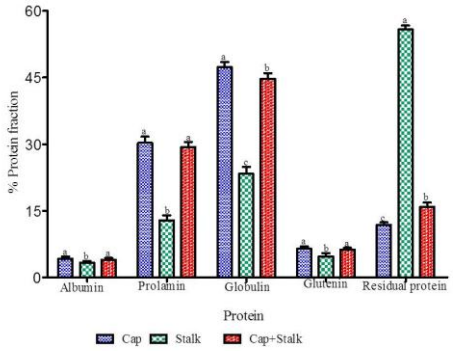

Figure 1: Bar Chart Showing Different Protein Fraction of Edible Oyster Mushroom

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