Available online at www.aexpbio.com

ISSN : 2348-1935

RESEARCH ARTICLE

Annals of Experimental Biology
2014, 2 (3):52-57

Survey and proximate analysis of edible mushrooms in Enugu State, Nigeria

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(Received:10-5-14) *(Accepted:24-6-14)*

ABSTRACT

A survey was carried out to identify the edible mushrooms in Enugu State, Nigeria. Mushrooms are highly priced delicacies which require expertise for proper identification because of the enormous risks associated with consumption of poisonous species. The survey covered the seventeen (17) Local Government Areas (LGA) in Enugu State. Results showed that eight (8) edible mushrooms namely Pleurotus tuber-regium, Auricularia auricula-judae, Lactarium triviralis, Russulla vesca, Termatomyces mammiformis, Schizophyllum commune, Lentinus squarrosulus and Tuberia sp. were commonly found in all the Local Government Areas surveyed. Proximate and mineral analyses of the mushrooms showed that they contain protein, carbohydrate, crude fibre, crude fat, ash and moisture in varying proportions. P. tuber-regium had the highest percentage of carbohydrate content (60.9 ± 1.0) followed by L. squarrosulus (49.4 ± 1.0) while the least was T. mammiformis (37.6 ± 2.0). The highest percentage protein was obtained in T. mammiformis (38.4 ± 2.0) followed by S. commune (28.3 ± 1.0) while P. tuber-regium had the least (17.5 ± 1.0). The percentage crude fibre, crude fat and ash were generally low. The mineral elements detected included potassium, calcium, magnesium, sodium, phosphorus, manganese, copper, iron, and zinc. Variations were observed in the concentrations of the major and minor elements in this study. Results of this study are clearly significant because of the information on mushroom nutrients. This information will affect mushroom consumers' choice given that mushrooms, egg, meat, milk and grain legumes have many of these components in common.

Key-words: composition, edible, mushrooms, poisonous, proximate, survey.

INTRODUCTION

Generally, mushrooms are the fruit bodies of fungi of the order Agaricales in the family Basidiomycetes. The order Agaricales comprise fungi whose fruiting bodies are commonly called mushrooms or toadstools. But while mushrooms refer to edible species toadstools refer the poisonous species. Morphologically, the two groups have very close resemblance and require expertise to distinguish. The most popular typical example of an edible mushroom is the genus *Agaricus* while *Amanita* is the notorious example of a poisonous mushroom and has caused many deaths following wrong identification [4]. Even closely related species of the same genus often differ in chemical compositions with one being perfectly safe for consumption and the other containing poisonous chemicals. For ages, mushrooms have been part of the normal human diet serving as food supplements in various cultures. They are cultivated and/or hunted for consumption for their edibility and delicacy. People who collect mushrooms for consumption are known as mycophagists [19] but the act of collecting them for consumption is known as mushroom hunting or simply "mushrooming". Nutritionally, Mushrooms are very rich in protein, carbohydrate,

minerals and vitamins [16]. Many species of mushrooms are medicinal and contain all essential amino acids as well as water-soluble vitamins and all the essential minerals [8]. Many reports abound in Nigeria on the use of mushrooms for the treatment of malnutrition in infants, diabetes, obesity, sterility, anemia, mumps, fever and protein deficiency [3, 23, 15, 24]. *P. tuber-regium* is a common species in southern part of Nigeria and it is useful in some combinations to cure headache, stomach ailments, cold and fever [25]. Mushrooms are edible for most people, and the larger species are a popular wild food where they occur for instance *Termitomyces titanicus*, which is the largest mushroom in the world, found in West Africa and Zambia.

Despite the numerous nutritional qualities of mushrooms, it must be emphasized that many species of mushrooms contain deadly poisons and have caused numerous deaths. There are many folk traditions concerning the defining features of poisonous mushrooms. But there are no general identifiers for poisonous mushrooms and the use of folk traditions to try to identify edible mushrooms is a frequent cause of mushroom poisoning [14]. Out of the many thousands of mushroom species in the world, only 32 have been associated with fatalities, and an additional 52 have been identified as containing significant toxins. The majority of mushroom poisonings do not lead to death [13]. The bulk of the lethal poisonings are due to the consumption of mushrooms in the group of *Amanita phalloides*. The application of folk knowledge from one geographic area to another [9] is a major cause of food poisoning arising from mushroom consumption. Mushrooms may be rendered poisonous by insecticide or herbicide sprays on lawns or reserves hence it is most advisable not to pick mushrooms in non-natural landscapes.

With all the nutritional qualities of edible mushrooms, it is interesting to remark that they are also relatively much cheaper than many of the known food items that contain similar nutrients. For instance, mushrooms are quite less priced than pork and chicken which are popular protein sources. Many mushrooms are high in fibre and other nutrients. This forms part of the justification for this study. To document the edible mushrooms indigenous to Enugu State, Nigeria as well as determine their individual nutritional values. Results of this study will give our people more insight into the food values of our indigenous edible mushrooms which are almost neglected as food sources in preference to exotic and most times more costly food items.

MATERIALS AND METHODS

Seventeen (17) Local Government Areas (LGAs) were covered in this survey of edible mushrooms in Enugu State of Nigeria. Enugu State is located between Latitude 5^0 and 6^0 N of the Equator and Longitude 6^0 E of the Greenwich Meridian. The survey was questionnaire-based and employed well structured questionnaires to obtain useful information from the local populace about mushrooms in their locality. Twenty (20) questionnaires were randomly distributed in each LGA to men and women (mostly farmers) resident in the LGA. The questionnaires were designed to obtain all the vital information about the edible mushrooms including local names, nutritional qualities and characteristic features, uses and mythology. Samples of some of the edible mushrooms observed in the fields were collected and taken to the laboratory at the Rubber Research Institute of Nigeria (RRIN), Iyanomo, near Benin City for identification.

NUTRITIONAL ANALYSIS:

Standard methods of analysis were employed to determine the food composition of the edible mushrooms collected [6]. The nutrients determined were crude protein, crude fibre, crude fat, carbohydrate, dry matter, ash, and moisture. The mineral elements determined included, potassium, calcium, magnesium, phosphorus, sodium, iron, manganese, copper and zinc. Moisture content was determined by heating 2g of each mushroom sample to a constant weight in a crucible in an oven at 105^oC. Crude protein (% total nitrogen x 6.25) was determined by the Kjeldahl method using 2g of each mushroom sample. Crude fat was obtained by exhaustively extracting 5g of each mushroom sample in a Soxhlet apparatus using petroleum ether (boiling point 40-60^oC) as the extractant. Ash was determined by the incineration of 10g sample placed in a muffle furnace at 550^oC for 6 hrs. Crude fibre was determined by digesting 2g of each mushroom sample with H_2S0_4 and NaOH and incinerating the residue in a muffle furnace also at 550^oC for 6 hrs.

The contents of potassium, calcium, magnesium, sodium, phosphorus, iron, manganese, cupper and zinc were determined employing standard procedures [7, 26, 21, 22]. Dried and ground edible mushroom samples were sieved with a 2mm rubber sieve. Two grams (2g) of each sample was weighed and subjected to dry ashing in a clean porcelain crucible at 550^oC in a muffle furnace. The resultant ash was dissolved in 5ml of $HNO_{3/}$ HCL/H_2O (1:2:3) and heated gently on a hot plate until brown fumes disappeared. To the remaining material in each crucible, 5ml de-

ionized water was added and heated until a colourless solution was obtained. The mineral solution in each crucible was transferred into a 100ml volumetric flask by filtration through a Whatman No. 42 filter paper and the volume made up with de-ionized water. This solution was used for elemental analysis by Atomic Absorption Spectrophometer (AAS). A 10cm-long cell was used and concentration of each element in the sample was calculated according to the percentage of dry matter. Phosphorus content of the digest was determined calorimetrically according to the method of Nahapetian and Bassiri, (1995).

RESULTS

Results of the survey showed that eight edible mushroom species were identified all together in the seventeen LGAs of Enugu State, Nigeria. Responses to the questionnaires showed that these mushrooms were common among the people who also consume them. These edible mushrooms were identified as *Pleurotus tuber-regium, Auricularia auricular, Lactarium triviralis, Russula vesca, Termitomyces mammiformis, Schizophyllum commune, Lentinus squarrosulus* and *Tuberia* sp. (Table 1). During this survey, it was observed that the mushrooms grew in cultivated or fallow farmlands (Plate I), termite hills, tree trunks, decaying bunches of male and female inflorensces of oil palm trees, and decaying wood logs. Mushrooms were found growing on enumerated habitats during the rainy seasons (between May and October) when humidity is very high. But in the course of this study, mushrooms such as *P. tuber-regium* and *L. squarrosulus* were found on their hosts (usually decaying tree trunks) throughout the year.

The most frequently occurring mushrooms in this study were found to be *T. mammiformis, A. auricular* and *P. tuber-regium* in this order while the least in occurrence was *Tuberia* sp. (Table I). *P. tuber-regium* produces big round sclerotia or "under ground tubers" as well as mushrooms. Both the tuberous selerotia as well as mushrooms are edible. The sclerotia or storage tuber are usually found within the decaying tree trunks (usually palm tree). The sclerotia are round, dark-brown with milky white interior. *S. commune* is one of the widely occurring mushrooms found in all the LGAs of the State. It is often waxy and lobed with a rigid margin. It is slippery when moist with a grayish-white colour growing up to 4cm in diameter. *L. squarrosulus* was found growing on dead tree trunks with a milky cap and stem. It has a tough texture even after cooking and can store for a long time after sun-drying or smoking. The other mushrooms namely *A. auricular, T. mammiformis, L. triviralis, R. vesca* and *Tuberia* sp. have soft, freshy caps with gills and long stems.

Table I: Mean Percentage Frequency of Occurrence of Edible Mushroom species in Seventeen Local Government Areas of Enugu State, Nigeria

Mushroom Species	Mean (%) Frequency of Occurrence
Pleurotus tuber-regium	20.7±2.01
Auricularia auricular	22.2±1.79
Lactarium triviralis	9.5±1.12
Russulla vesca	7.4±2.0
Termitomyces mammiformis	24.2±1.13
Schizophyllum commune	10.3±1.21
Lentinus squarrosulus	3.7±0.78
Tuberia sp.	2.1±0.28

Results of the proximate analysis of the edible mushrooms showed that there was significant difference ($P \leq 0.05$) in the nutrient contents of the edible mushroom species. The highest amount of carbohydrate was obtained from *P. tuber-regium* followed by *L. squarrosulus* and *R. vesca* while *T. mammiformis* and *S. commune* have the least. With regards to protein content, *T. mammiformis* has the highest while *P. tuber-regium* has the lowest (Table II). Crude fibre was found to be highest in *L. squarrosulus* and *L. triviralis and* lowest in *T.* mammiformis and *A. auricular*. The ether extract (crude fat) was found to be generally low in all the mushroom samples while moisture was moderately high in all the mushrooms species analyzed.

a b

Plate I: Mushrooms (a) (*Termitomyces* sp.), (b) *Russulla* sp. Observed During Field Survey of Seventeen LGAs of Enugu State, Nigeria

The result of macro (major) mineral composition showed that potassium and calcium contents were higher than other macro elements in all the mushroom species analyzed. No significant difference was observed between the K and Ca contents in this study ($P \leq 0.05$) but significant difference was observed between K and other macro-elements. Sodium (Na) and P had the lowest values for macro mineral contents (Table III). For the micro nutrients, results showed that manganese and iron contents were significantly higher than that of copper (Table IV). *P. tuber-regium* had the highest content of manganese followed by *L. squarrosulus* while *S. commune* and *T. mammifromis* have the lowest contents. The highest value for iron content was obtained in *L. squarrosulus* followed by *A. auricular*. Copper and zinc contents were very low in all the mushroom species.

Table II: Nutrient Compositions (%)* of Eight Edible Mushrooms

Mushroom sp	Crude Carbohydrate	Crude Protein	Crude fibre	Fat	Ash	Moisture
P. tuber-regium	60.93±1.23	17.47±1.17	2.01±0.16	0.78±0.08	2.67±0.53	18.15±1.12
A. auricular	42.82±1.89	25.37±2.05	1.77±0.11	1.12±0.18	1.82±0.48	27.10±1.21
L. triviralis	44.60±0.86	22.83±1.63	3.62±0.67	1.26±0.24	3.51±0.94	23.18±1.08
R. vesca	46.28±1.64	23.62±1.95	3.17±0.88	2.35±0.37	2.66±0.16	21.92±1.19
T. mammiformis	37.64±2.18	38.35±2.13	1.34±0.71	1.19±0.42	0.81±0.70	20.67±1.18
S. commune	37.69±2.12	28.26±1.12	2.18±0.23	1.18±0.47	1.08±0.12	29.61±1.81
L. squarrosulus	49.43±1.11	26.23±1.78	4.53±0.12	0.89±0.16	1.14±0.44	18.78±1.13
Tuberia sp.	39.12±2.37	20.53±1.87	2.72±0.21	1.76±0.36	2.26±0.52	33.61±1.27

**Values are means of triplicates*

Table: III Macro-Mineral Compositions (mg/100g) of Eight Edible Mushroom Species

Mushroom sp.	Macro-minerals				
	K	Ca	Mg	Na	P
P. tuber-regium	3.16	5.26	2.62	0.81	0.74
A. auricular	3.78	5.81	1.94	0.93	0.43
L. triviralis	5.92	5.86	2.42	0.61	0.52
R. vesca	4.27	4.82	1.05	0.38	0.33
T. mammiformis	5.6	4.66	2.94	0.45	0.47
S. commune	4.82	4.56	2.18	0.73	0.83
L. squarrosulus	3.65	3.97	2.00	0.65	0.35
Tuberia sp.	3.51	3.28	1.74	0.42	0.28
Mean	**4.34±0.3**	**4.78±0.3**	**2.11±0.1**	**0.62±0.1**	**0.49±0.1**

Table IV: Micro-Mineral Compositions (mg/100g) of Eight Edible Mushroom Species

Mushroom sp.	Micro-minerals			
	Mn	Cu	Fe	Zn
P. tuber-regium	1.87	0.76	1.17	0.85
A. auricular	1.05	0.62	2.11	0.66
L. triviralis	0.91	0.87	2.06	0.78
T. mammiformis	0.88	0.56	1.82	0.00
S. commune	0.75	0.65	1.67	0.62
L. squarrosulus	1.75	0.75	2.2	0.89
R. vesca	1.12	0.79	1.17	0.00
Tuberia sp.	1.04	0.82	1.22	0.37
Mean	**1.77±0.2**	**0.70±0.1**	**1.68±0.2**	**0.52±0.1**

DISCUSSION

Results of this study have revealed that many edible mushrooms abound in Enugu State of Nigeria though not given much attention as a source of food by the inhabitants. These mushroom species were found to occur in different environments. Some like *P. tuber-regium* and *L. squarrosulus* grew on decaying tree trunks such as palm tree trunks or buried in the decaying palm trunks. *T. mammiformis* usually occurred on or around anthills. Some grew on farmlands, forest floors etc. Mushrooms have been reported to be edible for most people, and that the larger species are a popular wild food where they occur. The largest mushroom in the world, *Termitomyces titanicus* is known to be native to West Africa and Zambia, with a cap reaching about 1 metre (3ft). These fungi grow on 'combs' which are excreta from the termites, dominated by tough woody fragments [12, 1].

Apart from *P. tuber-regium* which was found in many of the Local Government Areas surveyed through all the seasons, other mushrooms usually occurred only during the rainy season (April-October). The specific period of occurrence of these edible mushrooms, however, differs. For instance, *Tuberia* sp. was observed in this study with the early rains (April-June) while some others were found at the peak of the rainy season (July-October.). Roughly 150,000 types of mushrooms have been reported in the UK [1]. For purposes of identification, it is advised that multiple sources of identification be used for identifying mushrooms. The mushrooms are in season in the UK at different times. For instance, *Agaricus macrosporus* (July-Oct), *Boletus* sp. (June-Dec), common puffball (July-Nov) and *Russulla* sp. (Aug-Nov). Availability of mushroom is strongly related to weather conditions. Humidity plays a vital role in the occurrence and growth of mushrooms and most of the edible mushrooms encountered in this study were found growing on moist substrates. Ezeibekwe *et al*. (2009) had reported that mushrooms require moderate rainfall and pH range of 3-10 for their growth. They also reported that mushrooms are found in areas with temperature range of 20^{o}C. This is in agreement with the observation of this study because mushrooms were only found in cool areas in all the places surveyed.

Results of the proximate (nutrient) analysis of mushrooms in this study showed that they contain high quality carbohydrate and an appreciable amount of protein, crude fibre, crude fat and ash. This finding showed that edible mushrooms compared favourably with those reported for most legumes. Mushrooms are often grouped with vegetables and provide many of the nutritional attributes of vegetables as well as attributes more commonly found is meat, beans or grains. Dietary mushrooms are a good source of vitamin B, vitamin D [17] and the essential minerals, selenium, copper and potassium. Mushrooms are low in calories, fat-free, cholesterol-free, gluten-free and very low in sodium.

The highest amount of protein in this study was obtained in *T. mammiformis*, followed by *S. commune, L. squarrosulus* and *A. auricular,* in this order. Both carbohydrate and moisture contents were generally high in all the edible mushrooms studied This result differed from the findings of Ezeibekwe *et al*. (2009) who reported more protein in *P. tuber-regium* than in *T.* m*ammiformis* and *A. auricular*. The high contents of carbohydrate and moisture suggest that great care must be taken in mushroom handling and preservation because these high contents would increase mushroom susceptibility to fungal and bacterial infections. Results of mineral composition showed that edible mushrooms were rich sources of mineral elements. This result agrees with the reports of several researchers [10, 18, 2]. The importance of minerals in our diet cannot be over emphasized given their roles in metabolic reactions, rigid bone formation and osmoregulation among others.

In conclusion, this study has clearly shown that edible mushrooms have great potentials in supplementing the protein and mineral deficiency prevalent in developing nations in general and Nigeria in particular with her large population. It is hereby recommended that government at all levels should find a way of sponsoring school leavers into mushroom farming and so make more protein and other food supplements available to the ever increasing population. This way too, government would have been solving the problem of unemployment at the same time.

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