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Full Length Research Paper

Proximate and mineral analysis of some wild edible mushrooms

I. O. Okoro* and F. I. Achuba

Department of Biochemistry, Faculty of Science, Delta State University, Abraka, Delta state, Nigeria.

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Proximate and mineral analysis of five species of mushroom, *Lentinus squarrosulus, Volvariella volvacea, Coprinus micaceus, Lepiota procera*, and *Auricularia auricula* were examined in this study to determine their nutritional value. These mushrooms were found to contain on the average, 3.24 to 8.70% of crude fibre; 4.12 to 11.12% of ash; 0.90 to 2.58% of fats and oil; 12.02 to 27.00% of protein; 13.01 to 92.02% of moisture and 21.11 to 68% of carbohydrate. The average mineral element content of the mushrooms was found to be 144 to 1321 mg/100 g of potassium; 122 to 364 mg/100 g of sodium; 164 to 549 mg/100 g of calcium; 26 to 53 mg/100 g of magnesium; 738 to 1537 mg/100 g of phosphorus and 120 to 432 mg/100 g of iron. The overall nutritional potential of the five mushroom species was quite good. These results show that these species of mushroom are highly nutritive. These findings were discussed in line with the importance and implications of the uses of edible mushrooms to man.

Key words: Edible mushroom, mineral composition, proximate analysis.

INTRODUCTION

The consumption of mushrooms is now assuming greater importance in human diet worldwide, but many people are apprehensive about mushrooms as a food source. Ignorance has led many to become sceptical about whether food of fungal origin can hold any great nutritional promise. It seems much education is needed before full advantage can be taken of this readily available, nutritionally rich food source (Chang and Mshigeni, 2001; Crisan and Sands, 1978). Mushroom eating is still not popular in some parts of Nigeria today. This is due to the fact that mushrooms and fungus in general grow on decaying organic matter and waste substrates, coupled with the fact that some mushrooms are poisonous. However, in other parts of Nigeria, mushrooms are regular source of food to them (Oso, 1975; Nwokolo, 1987). Mushrooms have assumed greater importance in the diets of both rural and urban dwellers, unlike previously when consumption was confined to rural dwellers. Mushrooms are now marketed along highways and urban centres (Aremu et al., 2008). Most of the mushrooms consumed in Nigeria are picked by rural dwellers from farmlands, forests and around waste dump sites when environmental conditions particularly humidity favour their sporocarp formation. They are relatively much cheaper than beef, pork and chicken that contain similar nutrients. Also, Africa is very rich in edible species of mushroom and many people in African countries still depend on collection of wild edible mushrooms (Peter, 1991; Masuka and Utete, 1996).

Mushrooms represent one of the world's greatest untapped resources of nutritious food. 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). Mushrooms are rich in protein, minerals, and vitamins, and they contain an abundance of essential amino acids (Sadler, 2003). Therefore, mushrooms can be a good supplement to cereals (Chang and Buswell, 1996).

Mushrooms are saprophytes. They include members of the Basidiomycota and some members of the Ascomycota. They consist of two main parts, the mycelium and the fruity body (sporocarp). The mycelium consists of a treelike structure called hyphae hidden in the soil. The mycelium absorbs food nutrients while the hyphae form into mycelia which forms the fruit (sporocarp) structure on the surface when atmospheric conditions particularly

*Corresponding author. E-mail: israelik@yahoo.com.

humidity is favourable. The spore producing tissue is called the hymenium (Etang et al., 2006). Mushrooms vary in sizes, colour, texture and structure that favour their spore formation. The cap is called the cuticle and varies among different mushroom species, being sticky or slimy in texture. The stalk is the stem-like structure on which the cap is mounted and this varies in length depending on the species (Gyar and Ogbonna, 2006). Many species of mushrooms are edible, for example, *Plevritis* sp., *Agricus bisporus* (J. Lange) *Imbach* and *Volvariella volvaceae* (Bulliard ex Fries) Singer. Some are medicinal like *Tremella fuciformis* Berk., for maintaining healthy lung tissue, while others are poisonous like *Pholiota semarrasa* and *Amanta vaginata* (Bull.: Fr.) Lam. (Chang and Buswell, 1996).

Mushrooms have been a food supplement in various cultures and they are cultivated and eaten for their edibility and delicacy. They fall between the best vegetables and animal protein source. Mushrooms are considered as source of proteins, vitamins, fats, carbohydrates, amino acids and minerals (Jiskani, 2001). All essential amino acids are present as well as water soluble vitamins and all the essential minerals (Buigut, 2002). Mushrooms are good sources of vitamins like riboflavin, biotin and thiamine (Chang and Buswell, 1996). It has been indicated that mushroom is about 16.5% dry matter out of which 7.4% is crude fibre, 14.6% is crude protein and 4.48% is fat and oil. The protein value of mushrooms is twice as that of asparagus and potatoes, four times as that of tomatoes and carrots, and six times as that of oranges (Jiskani, 2001). Their energy value also varies according to species, which is about equal to that of an apple.

A common species of mushroom found in southern part of Nigeria is *Pleurotus tuber-regium.* It is useful in some combinations to cure headache, stomach ailents, colds and fever (Oso, 1977), asthma, smallpox and high blood pressure (Oso, 1977; Fasidi and Olorunmaiye, 1994), while *Lentinus tuber-regium* and *Lentinus tigrinus* are used for treating dysentery and blood cleansing respectively. *Auricularia* specie has been traditionally used for treating hemorrhoids and various stomach ailments (Chang and Buswell, 1996). Chanterelles, *Boletus edulis* and *Lactarius* spp. are used for killing flies, while the puffballs are used for healing wounds (Harkonen, 1998; Delena, 1999). They are also recommended to diabetic and anaemic persons, owing to their low carbohydrate and high folic acid content. Some mushrooms are reputed to possess anti-allergic, anti-cholesterol, anti-tumor and anti-cancer properties (Jiskani, 2001).

With the present high cost of meat and fish, many Nigerians are turning to mushrooms as an alternative source of protein. A limited amount of research has been carried out on the nutritive value of Nigerian mushrooms (Oke, 1966; Oso, 1977; Ogundana and Fagade, 1982).

The objective of this study was to determine the biochemical composition of five different wild edible mushrooms species, in terms of moisture, protein, crude fat, carbohydrate, fibre, ash and micronutrient elements. It is hoped that the results may be valuable for chemo-taxonomical and will encourage people to embark on their husbandry.

MATERIALS AND METHODS

Collection and treatment of samples

Mushrooms grow abundantly in the wild during the rainy season in every part of Delta State, Nigeria. Fruiting of five mushroom species were harvested from decaying logs and oil palm stalks dump site inside a bush located at Abraka, Delta State, Nigeria. The mushroom species were identified by a mycologist in the Department of Botany, Faculty of Science, University of Benin, Benin City, Edo State, Nigeria as *Lentinus squarrosulus, V. volvacea, Coprinus micaceus, Lepiota procera and Auricularia auricula*. Sample preparation was done as follows: after harvest, the fruit bodies were cleaned by gentle wiping with a cloth to remove any debris. Except for moisture and ascorbic acid determination, which were performed immediately after harvesting, dried samples were used. Dried samples were ground using a laboratory mill to pass through 1 mm sieve. All ground samples were transferred to airtight plastic bottles with well fitting caps, labelled and then sealed in polythene bags to prevent any water intake and were stored in a refrigerator at 4°C until required for analysis. The cold stored samples were allowed to attain room temperature and mixed thoroughly with a spatula before withdrawing samples for further proximate constituent analysis. Proximate analysis was done on ground samples in triplicate for each sample to yield results from which mean compositions were computed. All reagents were of analytical grade and used as obtained.

Analytical methods

Standard procedures of AOAC were used to determine the moisture content, crude fibre, crude fat, total nitrogen (Kjeldahl method) and ash (AOAC, 2002). In the fruit body of edible mushrooms, a large amount of nitrogen is actually contained in non-protein compounds; hence, the conversion factor of total nitrogen into crude protein is 3.45 to 4.38 (Braaksman and Schaap, 1996; Shah et al., 1997). In this study, crude protein was calculated using the conversion factor of (N x 4.38); a correlation factor adopted for mushrooms in food composition tables (Crisan and Sands, 1978). The content of ascorbic acid was determined by a titration method using the 2, 6 dichlorophenolindophenol Tillmans reagent (Tillman's method) (AOAC, 2002). The results were expressed in milligram of ascorbic acid per 100 g of sample. Mineral constituents (calcium, phosphorous, sodium, potassium, magnesium and iron) were determined by atomic absorption spectrophotometry (AOAC, 2002). The percentage of crude protein, crude fat, minerals and ash were combined and subtracted from 100 to obtain the total carbohydrate percentage for each sample.

Statistical analysis

The data on nutritive content determined for the five edible wild mushrooms species were subjected to analyses of variance (one way ANOVA) significance was accepted at the 5% probability level using the Statistical Package for Social Sciences (SPSS) Program

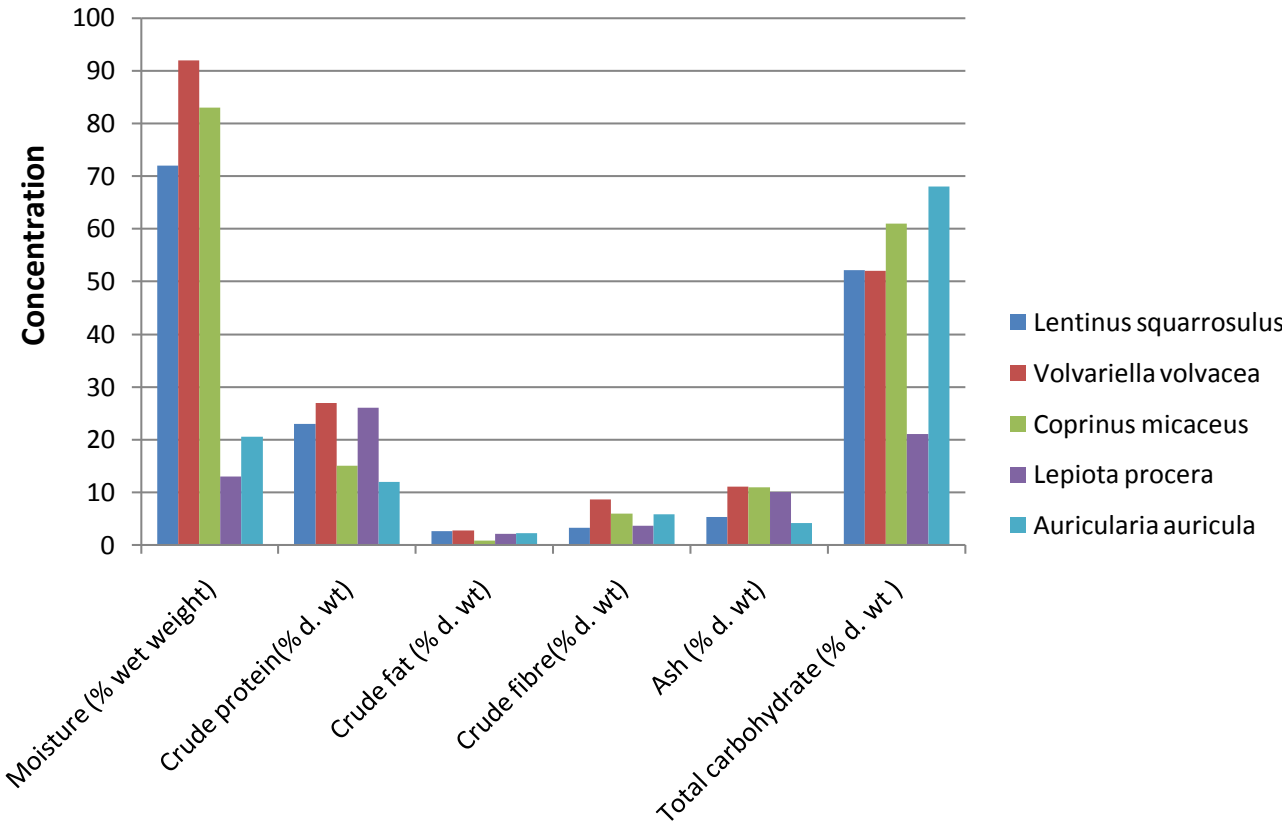

Figure 1. Proximate nutrient compositions of the mushroom samples.

10.1 version (SPSS, 1999). Data for proximate nutrient composition and for mineral constituents were reported as the mean ± SD for three determinations per sample. The results were given as mean ± SD.

RESULTS

The results of the proximate composition are presented in Figure 1. *V. volvacea* had the highest concentration of protein (27±1.02%) followed by *L. procera* and *L. squarrosulus*, while *A. auricular* had the least value of 12.02±2.1%. With respect to moisture content, *V. volvacea* had the highest value (92±0.12%) and *L. procera* the least value (13.01±0.2%). *A. auricular* had the highest carbohydrate value (61±0.32) and crude fibre was highest in *V. volvacea* (8.7±0.22). The ether extract (lipid) of *V. volvacea* gave the highest value of 2.80±0.21% and the least was *C. micaceus* (0.90±0.01%). Minimum and maximum ascorbic levels in the present study were 1.34±0.2 mg/100 g d.w. and 58±0.14 mg/100 g d.w. for *A. auricular* and *L. squarrosulus*, respectively. Results in Figure 2 showed values of the mineral compositions. Calcium content was 549±0.6 mg/100 g dry weight for *L. squarrosulus* and 164±2.01 mg/100 g d. w. for *A. auricular*. *L. procera* and *C. micaceus* had the highest sodium content of 364±0.12 and 289±3.1 mg/100 g dry weights respectively. *V. volvacea* had the highest potassium concentration (1321±1.05 mg/100 g) and *A. auricular* had the least content (151.26±1.3 mg/100 g). *V. volvacea* had the highest phosphorus content, followed by *L. squarrosulus* and *C. micaceus*. *V. volvacea* had the highest magnesium content (53±1.40 mg/100g). The iron content varied from *L. procera* with 119±2.1 mg/100 g d.w to *V. volvacea* with 432±1.40 mg/100 g.

DISCUSSION

Proximate analysis was carried out on five edible mushroom species: *L. squarrosulus, V. volvacea, C. micaceus, L. procera and A. auricular*. They were selected based on their availability at the time of analysis. The results of the proximate analysis of the five species of edible mushroom showed that the mushroom are richly endowed with protein, fibre, ash, moisture, fat, carbohydrates and mineral elements. This agrees with the finding of Moore and Chi (2005) that edible mushrooms have high nutritional attributes and potential applications in industries. The crude protein, ash and crude fibre values of most mushrooms compared favourably with and in some instances surpassed those reported for most legumes except groundnut and soybeans grown in West

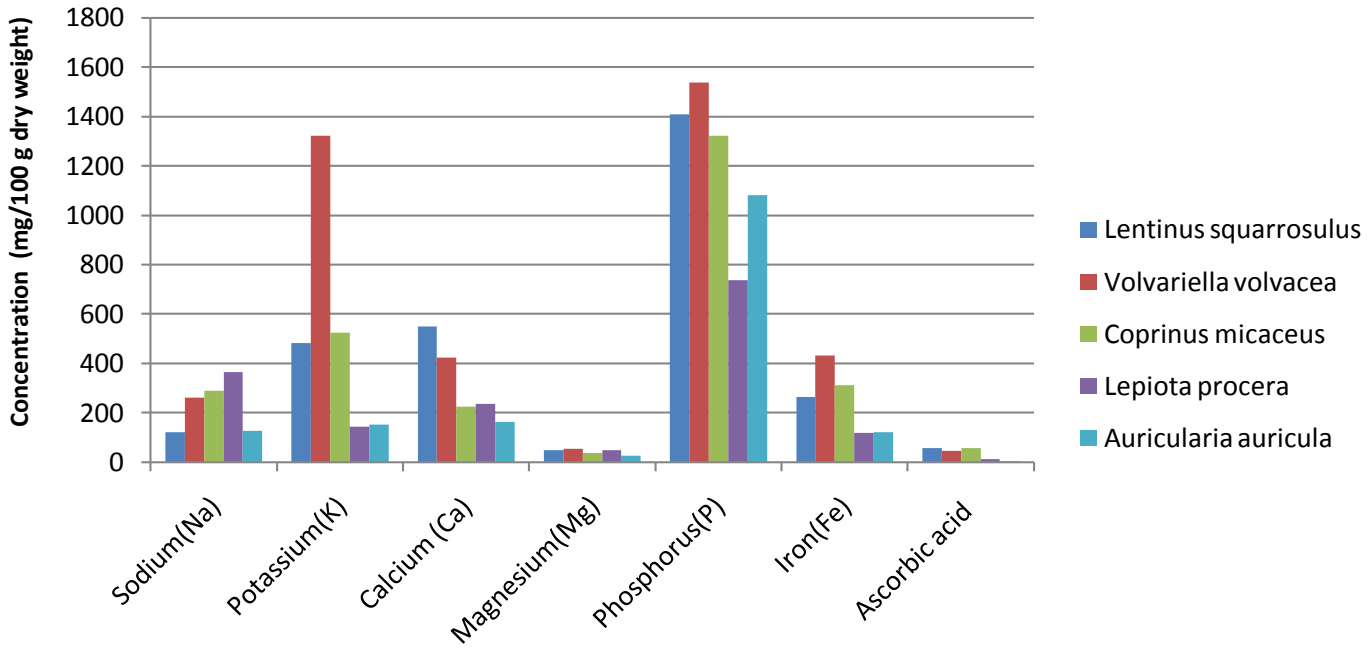

Figure 2. Concentrations of Na, K, Ca, Mg, P, Fe and ascorbic acid of analyzed mushroom samples (mg/100 g dry weight).

Africa (FAO, 1970; Aletor and Aladetimi, 1989). The mineral levels, mainly potassium, phosphorous, sodium and iron in these mushrooms were higher than those reported for several cowpea varieties (Aletor and Aladetimi, 1989), but lower than those reported for fish, snails and broiler meat (Imevbore, 1992). Using this proximate analysis, the mineral and analytical food value as approximate indices of nutritional quality, it would appear that some of these mushrooms fall between most legumes and meat. In earlier studies, Gruen and Wong (1982) indicated that edible mushrooms were highly nutritional and compared favourably with meat, egg and milk. Some of the mushrooms are known to possess antitumorigenic and hypocholesterolaemic agents, which implies that mushrooms could hold special attraction for and may be recommended for people with cholesterol-related ailments (Chihara, 1993). The results of the study showed appreciable levels of fibre which is known as anti-tumorigenic and hypochlestrolaemic agent. This implies that mushrooms hold special attraction and may be recommended for people with cholesterol related ailment (Kadiri and Fasidi, 1990). The moisture contents of some of the mushrooms analyzed are high, indicating that mushrooms are highly perishable. High moisture contents promote susceptibility to microbial growth and enzyme activity. *V. volvacea* has the highest protein, moisture, ash and crude fibre content of the five species. The high moisture and protein content especially in *V. volvacea* suggests that great care must be taken in their handling and epresentation as high moisture contents promote susceptibility to microbial growth and enzyme activity. The results show that the five species of mushrooms were rich in nitrogen and were found to contain reasonable levels of the minerals analysed. This is in agreement with results of the study of some cultivated mushrooms (*Agaricus bisporus* and *Pleurotus osterotus*) by Edeoga and Gomina (2000). In addition, it is also known that the moisture content of mushrooms depends on their harvesting time, maturation period and environmental conditions such as humidity and temperature in growing period, and storage conditions, Crisan and Sands (1978). The moisture content of all studied mushroom species ranged from 13.01±0.2 to 92±0.12. Mushrooms are consumed for low-calorie diet because of their low crude fat content. The major compounds of mushrooms are proteins and carbohydrates. It is reported that the protein contents of mushrooms are affected by a number of factors, namely the type of mushrooms, the stage of development, the part sampled, level of nitrogen available and the location, Flegg and Maw (1977). It can be understood from the data that the studied mushrooms are good protein source. Mushroom carbohydrates include glucans, mono- and disaccharides, sugar alcohol, glycogen and chitin (Kurztman, 1997). The trace metal content of mushrooms are related to species of mushroom, collecting site of the sample, age of fruiting bodies and mycelium, distance from sources of pollution (Kalac et al., 1991) and are mainly affected by acidic and organic matter content of the soil. Metal ion uptake of mushrooms is considerably higher than plants because of their effective take up mechanism (Lepsova and Mejstrik, 1988). The results of mineral values of the five edible species of mushrooms clearly indicate the potential for their use as sources of good quality food. Minerals in the

diet are required for metabolic reactions, transmission of nerve impulses, rigid bone formation and regulation of water and salt balance among others.

Conclusion

The results of the proximate analysis of the five species showed that *V. volvacea* had the highest levels of crude protein, moisture and crude fibre. It can be said following the results of this study that these edible mushrooms hold tremendous promise in complementing the protein and minerals supply deficiencies prevalent in developing countries since mushrooms are highly nutritional and can compare favourably with egg, meat and milk. However, for the nutritional potential of mushrooms to be realized, sustained efforts must be geared towards the cultivation and popularization of these studied mushrooms (*L. squarrosulus, V. volvacea, C. micaceus, L. procera and A. auricular).* Edible mushrooms are grown with little efforts in their husbandry: they are grown on straw based compost, and sawdust supplemented with other nutrients. It can be conclude that the investigated wild edible mushrooms are good food sources in terms of protein, carbohydrate, crude fat, and crude fibre and may be cultivated.

REFERENCES

Aletor VA, Aladetimi OO (1989). Compositional evaluation of some cowpea varieties and some underutilized edible legumes in Nigeria. Die Nahrun 33: 99-1007.

AOAC (2002). Official Methods of Analysis -17th ed. Association of Official Analytical Chemist, Maryland.

Aremu MO, Basu SK, Toma GA, Olowoniyi FD (2008). Evaluation of the nutritional value of three types of edible mushrooms found in Nasarawa State, Nigeria. Bangladesh J. Prog. Sci. Tech. 6(2): 305–308.

Braaksman A, Schaap DJ (1996). Protein analysis of the common mushrooms *Agaricus* bisporus. Post. Harv. Biol. Technol. 7: 119-127.

Buigut SK (2002). Mushroom production in sustainable small-scale farming system-opportunities and constraints: a survey of Uasin Gishu district. In: Proceedings of the Holticulture seminar on Sustainable Horticultural Production in the Tropics at Jomo Kenyatta University of Agriculture & Technology, Juja, Kenya 3rd-6th October, 2001. Eds. Wesonga JM, Losenge T, Ndung'u CK, Fricke A, Hau B, Stützel H (2002). pp. 1-5.

Chang ST, Buswell JA (1996). Mushroom neutraceuticals. World J. Microbiol Biotechnol. 12(5): 473 – 476.

Chang ST, Mshigeni KE (2001).Mushroom and their human health: their growing significance as potent dietary supplements. The University of Namibia, Windhoek. pp. 1-79.

Chihara G (1993). Medicinal aspects of Lentian Isolated from *Lentinus edodes* (Berk). Hong Kong, Chinese University Press. pp. 261-266.

Crisan EV, Sands A (1978). Nutritional value. In: Chang ST and Hayes WA (Eds). The Biology and Cultivation of Edible Mushrooms. London, Academic Press Inc, pp 137-165.

Delena T (1999). Edible and Useful Plants of Texas and the SouthWest-A Practical Guide. 2003-5 University of Texas Press. p. 542.

Edeoga HO, Gomina A (2000). Nutritional values of some non-conventional leaf vegetables of Nigeria .Journal of Economic Botany 24: 7-12

Etang BB , Essian JP, Odejimi RAO (2006). Nutritional and bacteriological quality of mushroom from Niger-Delta rainforest of Nigeria. Nig. J. Microbiol. 20(2): 965 – 975.

FAO (1970). Food and agricultural Organization (No 12) FAO, Rome, Italy.

Fasidi IA, Olorunmaiye KS (1994). Studies on the requirements for vegetative growth of Pleurotus tuber-regium (Fr.) Singer, a Nigerian mushroom. Food Chem. 50: 397-401.

Flegg PB, Maw G (1977). Mushrooms and their possible contribution to world protein needs. Mushroom J. 48: 395-403.

Gruen VEC, Wong HX (1982). Immunodulatory and Antitumour activities of a polysaccharide-peptide complex from a mycelial culture of *Trichoderma* sp. Sciences, 57: 269-281.

Gyar SD, Ogbonna CIC (2006). Comparative study on nutrient and mineral profiles of mushroom species *Macrolepiota procerus* cultivated on two *Mansonia altissima* sawdust formulations. Adv. Food Sci. 28(4): 1 – 4.

Harkonen M (1998). Uses of mushrooms by Finns and Karelians. Int. J. Circumpolar Health, 57 (1): 40-55.

Imevbore EA (1992). Perspectives of snail farming in tropical Africa: the Nigerian situation. In: Proc. Invertebrates (Microlivestock) Farming Seminar, La Union, Philippines.

Jiskani MM (2001). Energy potential of mushrooms. The DAWN Economic and Business Review, Oct. 15-21, 2001. p. IV.

Kadiri M, Fasidi IC (1990). Studies on enzyme activities of *Plerotus tuber regium Hein* at various fruitbody stages. Nahrung, 34(8): 695-999.

Kalac P, Burda J, Staskova I (1991). Concentrations of lead, cadmium, mercury and Cooper in mushrooms in the vicinity of a lead smelter. Sci. Total Environ. 105: 109-119.

Kurztman RH (1997). Nutrition from mushrooms, understanding and reconciling available data. Mycoscience, 38: 247-253.

Lepsova A, Mejstrik V (1988). Accumulation of trace-elements in the fruiting bodies of macrofungi in the Krusnehory Mountains, Czechoslovakia. Sci. Total Environ. 76: 117-128.

Masuka AJ, Utete D (1996). Overview of mushroom production in Africa: Constraints, opportunities and strategies. Paper presented at the regional workshop on mushroom production and mushroom germplasm collection and conservation. Harare, 23-27 September, 1996.

Moore D, Chi SW (2005). Fungi products as food (eds) pointing, S.B and Hyde, K.O. In Bio-Explotation of filamentous fungi. Fungi Diversity Res. Lenis, 6: 223-251.

Nwokolo E (1987). Composition of nutrients in the sclerotium of mushroom pleurotuus tuber-regium. Plant Foods Human Nutr. 37: 133-139.

Obodai M, Cleland-Okine J, Vowotor KA (2003). Comparative study on the growth and yield of Pleurotus ostreatus mushroom on different lignocellulosic by-products. J. Ind. Microbiol. Biotechnol.; 30: 146-149.

Ogundana SK, Fagade OE (1982). Nutritive value of some Nigerian edible mushroom J. Food Chem. 8: 263-268.

Oke OL (1966). Chemical studies on the more commonly used leaf vegetables in Nigeria.West Afr. Sci. Assoc. 2: 42-49.

Oso BA (1975). Mushrooms and the Yoruba people of Nigeria, Mycolgia, 67: 311-319

Oso BA (1977). *Pleurotus tuber-regium* from Nigeria. Mycologia, 69: 271.

Peter O (1991). Manual on mushroom cultivation. Tool publications sarphat Istraat 650, 1018 AV Amsterdam. The Netherlands pp 17-25.

Sadler M (2003). Nutritional properties of edible fungi. British Nutrition Foundation Nutrition Bulletin, 28: 305-308.

Shah H, Khalil IA, Jabeen S (1997).Nutritional composition and protein quality of Pleurotus mushroom. Sarhad J. Agric. 13:621-627.

SPSS. Statistical package for Social Sciences (1999) Computer Program, MS for Windows. SPSS 10 for Windows, Chicago, Illinois, USA.