PROXIMATE COMPOSITION AND NUTRIENT CONTENT OF SOME WILD AND CULTIVATED MUSHROOMS OF GHANA

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ABSTRACT

Some chemical analysis and sensory data of the fruitbodies of eight mushroom species-Auricularia auricula, Coprinus disseminatus (Bull. ex. fr.) Fr, Pleurotus sajor-caju (Fr.) Sing. strain SH-l, Pleurotus sajor-caju (Fr.) Sing strain SM-1, Pleurotus ostreatus (Jacq. ex. fr) Kummer strain EM-l, Pluteus subcervinus (Schaeff Ex. Fr) Kummer, Termitomyces species and Volvariella volvacea (Bull ex. fr.) were investigated. Proximate composition: moisture, protein, fat, ash, carbohydrate; major mineral constituents (Na, Ca, P, K), one minor mineral (Fe) constituent and vitamin C content were determined. The protein content ranged from 6.2 to 30.9 percent; carbohydrate, a major constituent in mushroom species was highest in Pleurotus sajor-caju (Fr.) Sing. strain SH-l (77.2 percent) whilst Auricularia auricula contained 23.5 percent. Values for fat content ranged from 1.1 to 10.8 percent. Ash content ranged between 2.9 to 24.2 percent. Mineral content (P and K) in the mushroom sporophores were found to be higher than in many fruits, and vegetables. From the sensory data Termitomyces species was the most preferred and accepted of the mushrooms studied.

INTRODUCTION

More than 14,000 different varieties of mushrooms exist in nature (Lu, 2008), however, less than 200 of these are widely accepted as food and only about 80 are cultivated commercially. The total world production of mushrooms is well over 15 million tons (Lu, 2008) with China producing over 65% of the total (Xu, 2008). In recent years mushrooms are not only produced for food, but also for the medicinal properties they possess (Chang, 1999; Çaglarlrmak *et al.*, 2002; Lu, 2008).

Abundant resources of edible and medicinal mushrooms lie unutilised in most forests of Ghana. A recent survey carried out in the Bia Biosphere Reserve in the Western region of Ghana has revealed 24 different species of mushrooms. These comprise of eighteen (18) edible and six (6) medicinal mushrooms (Obodai and Apertorgbor, 2001). The edible mushrooms include the Termite mushroom. (*Termitomyces* sp), the oil-palm mushroom (*Volvariella* sp.), the Ink cap mushroom (*Coprinus disseminatus*), *Cantharellus* sp., *Mycena flavescens, Schizophyllum*

commune, Woodear mushroom (*Auricularia auricula*) and Button mushroom (*Agaricus* sp.), which belong to the orders Agaricales, Cantharellales, Tricholomatales, Schizophyllales and Auriculariales. The medicinal mushrooms are *Schizophyllum commune, Pleurotus tuber-regium, Auricularia auricula, Ganoderma lucidum, Clavatia* sp. and *Daldina concentrica,* which belong to the order Schizophyllales, Poriales, Auriculariales, Agaricales, Lycoperdales, and Xylariales respectively (Obodai and Apertorgbor, 2001).

Mushrooms are one of the many foods from the wild found in the diet of many Ghanaians. They are normally consumed fresh in the preparation of soups, stews and as condiments; however, use of the dried forms is not uncommon in the off-season. Collection of these edible mushrooms in the rural areas and subsequent sale at the urban centres is an old tradition and a well established activity which is gender-related and generally regarded as work for women and children. Interest in mushrooms as a natural source of food supply has increased over the past few years and cultivation of the oyster mushroom has really gained popularity (Obodai *et al.*, 2000). Mushrooms are good sources of proteins, vitamins and minerals but are low in fat. Nutritionally they rank between high grade vegetables and low grade meat (Garcha *et al.,* 1993; Chang, 1997). The protein contents of mushrooms are known to be affected by a number of factors namely the species of mushroom, the stage of development, the part sampled, the level of nitrogen available and the location (Flegg and Maw, 1977). Li and Chang (1982) established that the crude protein of *V. volvacea* at the elongation stage is 21.34 g/100 g and that at the button stage is 30.5 g/100 g. Mushrooms have also been found to have a good balance of amino acids compared to most plant foods (Kurtzman, 1993; Chang, 1997) and found to contain all nine essential amino acids required by man (Chang, 1989; Poppe, 2000). Since acute protein malnutrition is a glaring reality in developing countries, mushrooms with high protein content fit in well into the scheme to fight malnutrition.

Although a lot of work has been done on the nutritive value of mushrooms in other parts of the world there is no data on the nutritive value of both cultivated and wild edible mushrooms in Ghana. The present study was undertaken to determine the chemical composition of the cultivated oyster and some of the wild mushrooms found in Ghana in addition to its sensory analysis.

MATERIALS AND METHODS

Sample collection, transportation and packaging

The cultivated mushrooms used for the study were *Pleurotus sajor-caju* (Fr.) Sing. strain SH-l, from Thailand, *P. sajor-caju* (Fr.) Sing strain SM-1, and *P. ostreatus* (Jacq. ex. Fr) Kummer strain EM-l both from Mauritius and *Volvariella volvacea* (Bull ex. Fr.) Sing. from Ghana. The wild mushrooms, collected from Bia Biosphere Reserve in Ghana were *Auricularia auricula* (Woodear), *Coprinus disseminatus* (Bull. ex. Fr.) Fr. (Ink cap mushroom), *Pluteus subcervinus* and *Termitomyces* species (Termite mushrooms).

The wild mushrooms were collected fresh and brought to the laboratory in baskets for analysis within 24 h of picking. This resulted in the loss of the initial moisture content. The cultivated oyster mushrooms were grown on sawdust using the plastic bag method (Auetragul, 1984; Obodai *et al.* 2000), whilst the low-bed method of cultivation (Oei, 1996; Obodai *et al.*, 2003) using banana leaves as substrate was used for the oil-palm mushroom. The first harvest of mushrooms were used for the analysis. The whole mushrooms (pileus and stipe) were dried and powdered for analysis.

Chemical analysis

Proximate analysis of crude fat, protein and crude fibre, moisture and ash were performed according to standard methods (AOAC, 1990). The 4.38 factor was used to convert nitrogen to crude protein (Crisan and Sands, 1978). Total carbohydrate

was determined by subtracting the amount of ash, protein and fat from total dry matter. Energy values were calculated by Atwater's calculation i.e. the sum of (protein x 4, carbohydrates x 4 and fat x 9) (AOAC, 1990). Minerals (Na, K, Fe) were analyzed by the single beam spectrophotometer Model 295E after dry-ashing the samples (AOAC, 1990). Ca was determined by permanganate titration (Pearson, 1970). Phosphorus analysis was determined using the molybdovanate method (AOAC, 1990). Vitamin C was determined using standard methods (AOAC, 1990). All analysis were carried out in four replicates.

For the sensorial preference tests the hedonic scale (1-9) was used. Fifteen trained panelists were used in evaluating the wild mushrooms collected in terms of taste, aroma, mouthfeel, texture, appearance and overall acceptability. Means and standard deviations were calculated. Data were also submitted to analysis of variance and Duncan's multiple range tests at $P \leq 0.05$ using SPSS 10 for Windows (SPSS for Windows 1999).

RESULTS AND DISCUSSION

Protein one of the most important nutrients, with its sufficiency in a diet indicating its adequacy and quality was found to range from 6.2 to 30.90% among the mushrooms studied. The average protein content of the mushrooms studied was 20.0%. *Volvariella volvacea* recorded the highest value of 30.9% and *Auricularia auricula* the lowest value of 6.2% (Table 1). The crude protein content of the strains of *Pleurotus* species examined ranged from 19.6 to 20.1% this was comparable with 19.4% obtained by other authors (Bano and Rajarathanam, 1982). The 19.6% protein content obtained for *Termitomyces* sp. was much lower than the value of 39.2% reported (Patent and Thoen, 1977; Oei, 1996). The average protein content of the mushrooms studied was found to be higher than those of common food items which ranges from 7.6% in potato to 18.4% in cabbage and also 9.4% in corn to 12.7% in wheat but lower in egg and meat which contained 50.6% and 83% protein respectively (Bano, 1976; Chang, 1997). In view of the results obtained for the protein levels of *V. volvacea* in this study, it is suggested that cultivation of this mushroom be encouraged in areas where protein malnutrition is very prevalent especially in the tropics and sub-tropics.

Fat content varied from mushroom to mushroom. *Auricularia auricula* contained the highest value of 10.8% and the lowest (1.1-2.0%) was found in the *Pleurotus* strains. Çaglarlrmak *et al.* (2002) reported lower values for fat contents as follows *P. ostreatus,* 0.14% and *Volvariella volvacea,* 0.74%. *Coprinus disseminatus* had the highest ash content of 24.2% followed by *Pluteus subcervinus* and *V. volvacea. Auricularia auricula* had the lowest ash content of 2.9% (Table 1).

Carbohydrate is one of the major constituents of mushrooms. In the *Pleurotus* strains, the carbohydrate content ranged from 49.9 to 77.2% (Table 1) these values were within the range of 46.65 to 81.8% recorded by Bano and Rajarathanam (1982). Lower values of 27.1% and 23.5% were recorded for *Coprinus disseminatus* and *Auricularia auricula* respectively.

Mushrooms are rich sources of mineral elements such as potassium, sodium and phosphorus (Cheng, 1979; Li and Chang, 1982). Potassium and phosphorus were the main constituents of the ash of the *Pleurotus* species studied. *P. ostreatus* strain EM-l contained the highest value of 3334 mg/100 g for potassium (Table 2). Vitamin C was present in appreciable amount of 113.4 mg/100 g in *Pleurotus sajor-caju* strain SH-1.

In most Ghanaian homes *Termitomyces* species is the most popular mushroom, hence its high preference and acceptability from the sensory results (Table 3). This was followed by *Pluteus subcervinus. Coprinus disseminatus* ranked the lowest due to it's sandy mouthfeel. It however rated quite high for its aroma alone. There was significant difference ($P \leq 0.05$) for the overall acceptability of the mushrooms.

CONCLUSION

The cultivation and consumption of mushrooms should be encouraged. Results from the present study shows that most mushrooms are rich in proteins, carbohydrates, minerals and low in fat. This is very ideal to fight malnutrition in areas where it is prevalent. *Termitomyces* sp. is the most popular mushroom in Ghanaian homes.

Table 1: Proximate composition of cultivated and wild mushrooms (per 100 g sample)

Mushroom species	Composition (%)						
	Initial moisture	Crude protein	Crude fibre	Fat	Ash	Total carbo-hydrate	Energy value (Kcal.)
Termitomyces species	87.9	19.6	nd	2.9	9.8	36.7	229.8
Coprinus micaceus	75.7	23.6	nd	9.4	24.2	27.1	369.3
Pluteus subcervinus	86.0	20.2	nd	9.0	21.4	60.9	358.8
Auricularia auricula	71.9	6.2	nd	10.8	2.9	23.5	205.3
Pleurotus sajor caju strain SH-1	88.5	20.1	1.4	1.4	4.2	77.2	388.9
Pleurotus sajor caju strain SM-1	93.5	19.6	17.4	1.1	6.7	50.5	272.6
Pleurotus ostreatus strain EM-1	90.9	20.0	15.8	2.0	7.6	49.9	279.9
Volvariella volvacea	75.5	30.9	nd	4.0	15.2	49.3	321.3
Average	83.7	20.0	-	5.1	11.5	46.9	303.2

nd - not determined *Values are expressed on dry weight basis*

Table 2: Minerals and Vitamin C (ascorbic acid) content of some of the cultivated and wild mushrooms

Mushroom species	Composition (%)					
	Major mineral constituents mg/100 g				Minor mineral constituent mg/100 g	
	Na	Ca	P	K	Fe	Vitamin C mg/100 g
Termitomyces species	nd	99.3	239.4	nd	7.7	nd
Coprinus micaceus	nd	146.1	247.0	nd	7.6	nd
Pluteus subcervinus	nd	128.4	205.8	nd	11.1	nd
Auricularia auricula	nd	195.6	103.2	nd	9.6	nd
Pleurotus sajor caju strain SH-1	61.2	34.0	697	3289	24.9	113.4
Pleurotus sajor caju strain SM-1	51.8	41.6	863	2983	27.7	92.7
Pleurotus ostreatus strain EM-1	56.2	43.1	939	3334	42.6	99.8
Volvariella volvacea	96.4	157.4	1334	3305	44.2	62.1

nd not determined *Values are expressed on dry weight basis*

Table 3: Sensorial preferences of some wild mushrooms

Mushroom spp.	Sensorial characteristics					
	Taste	Aroma	Mouthfeel	Texture	Appearance	Overall acceptability
Auricularia auricula	6.00 (±1.57)	6.30 (±1.63)	5.70 (±1.54)	5.70 (±1.91)	5.70 (±1.91)	6.70 (±1.94)^{c}
Coprinus disseminatus	6.70 (±1.54)	7.00 (±1.31)	5.90 (±2.13)	5.80 (±2.05)	5.70 (±2.05)	6.00 (±2.24)^{d}
Termitomyces sp.	7.69 (±0.91)	7.80 (±0.94)	7.60 (±1.04)	7.40(±0.64)	7.80 (±0.64)	7.80 (±0.83)^{a}
Pluteus subcervinus	7.60 (±0.06)	7.60 (±0.91)	7.20 (±0.94)	7.00(±1.19)	7.20 (±1.09)	7.30 (±1.03)^{b}

Values in ( ) are s.d
Values in the same column followed by different alphabet are significantly different at $P \leq 0.05$

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REFERENCES

AOAC (1990). *Official Methods of Analysis of the Association of Official Analytical Chemists*. 15th edition. Virginia,USA. Association of Official Analytical Chemists, pp. 69-80.

Auetrugal, A. (1984). The highest aspects for cultivating oak mushroom (*Lentinula edodes*) in plastic bags. *Mushroom Newsletter for the Tropics* 5 (2): 11-15

Bano, Z. (1976). The nutritive value of mushrooms. *Proceedings of first symposium on survey and cultivation of edible mushrooms in India, R R L*. Sringarm 2: 172.

Bano, Z. and Rajarathanam, S. (1982). '*Pleurotus* mushroom as a nutritious food'. In: S.T. Chang and T. H. Quimo (Eds), *Tropical Mushrooms: Biological Nature and Cultivation Methods* The Chinese University Press, Hong Kong. pp. 363-380.

Çaglarlrmak, N., Ünal, K. and Ötles, S. (2002). Nutritional value of edible wild mushrooms collected from the Black Sea region of Turkey. *Micologia Applicada International* 14 (1): 1-5.

Chang, S.T. (1989). Mushroom as human food. *Bioscience* 30 (6): 399-401.

Chang, S.T. (1997). 'Nutritional and Medicinal properties of mushrooms'. In: K.E. Mshigeni, T.N. Ngwira, G.E. Kiangi, K. Mchombu, O.D. Mwandemele, M.E. Ngwira (eds). *Proceedings of the First West African Regional Workshop on Zero Emissions concept,* Benin.. 15-19 November, 1997, pp. 35-37.

Chang, S.T. (1999). World Production of cultivated edible and Medicinal mushrooms in 1997 with emphasis on *Lentinus edodes* (Berk) Sing. in China. *International Journal of Medicinal Mushrooms* 1: 291-293.

Cheng, S.C. (1979). Studies on the nutritive value of the straw mushroom, *Volvariella volvaceae*. M.Phil Thesis. The Chinese University of Hong Kong.

Crisan, E.V. and Sands, A. (1978). 'Nutritional value'. In: S.T. Chang and W.A. Hayes (Eds) *The Biology and Cultivation of Edible Mushrooms.* Academic Press Inc., London, pp. 131 -168.

Flegg, P.B. and Maw, G. (1977). Mushrooms and their possible contribution to world needs. *Mushroom Journal* 48: 395-403

Garcha, H.S., Khanna, P.K. and Sonn, G.L. (1993). 'Nutritional importance of mushrooms'. In: S.T. Chang, J.A. Buswell and S. Chiu (Eds). *Mushroom Biology and Mushroom Products.* The Chinese University Press, Hong Kong, pp 227-230.

Kurtzman, R.H. Jr. (1993). Analysis, digestibility and the nutritional value of mushrooms. In: S.T. Chang, J.A. Buswell and S. Chiu (Eds). *Mushroom Biology and Mushroom Products.* The Chinese University Press, Hong Kong, pp. 230-236.

Li, G.S.F. and Chang, S.T. (1982). Nutritive value of *V. volvaceae*. In: S.T. Chang and T. H. Quimo (Eds), *Tropical Mushrooms: Biological Nature and Cultivation Methods* The Chinese University Press, Hong Kong. pp. 199-219.

Lu, J. (2008). 'The status Quo and Prospect of China's edible Fungus Industry'. In: *Seminar on Edible Fungi Application and Dissemination for Officials*, Beijing, China, May 22-June 5, 2008, pp. 9-26.

Obodai, M., Sawyerr, L.C.B. and Johnson, P-N.T. (2000). Yield of seven strains of oyster mushrooms (*Pleurotus spp.*) grown on composted sawdust of *Triplochiton scleroxylon*. *Tropical Science* 40 (2): 95-99.

Obodai, M. and Apertorgbor, M. (2001). An ethnobotanical study of Mushroom germplasm and its domestication in the Bia Biosphere Reserve. CSIR Food Research Institute Man and the Biosphere Report.

Obodai, M., Cleland-Okine, J. and Johnson, P-N.T. (2003). Use of agricultural waste as substrate for the mushroom *Volvariella volvacea*. *Tropical Science* 43 (3): 121-124.

Oei, P. (1996). Manual on mushroom cultivation-techniques, species and opportunities for commercial application in developing countries. Netherlands CTA.

Patent, G. and Thoen, D. (1977). Food value of edible mushrooms from Upper-Shaba Region, *Economic Botany* 31: 436-445.

Pearson, D. (1970). Chemical analysis of food. 7th edition J&A Churchill, London, pp. 18-19

Poppe, J. (2000). Use of agricultural waste materials in the cultivation of mushrooms. *Mushroom Science* 15: 3-23.

SPSS 10 for Windows (1999). SPSS 10 for Windows. Chicago. IIIinois, USA.

Xu, H. (2008). 'Edible Fungus Market and Investment'. In: *Seminar on Edible Fungi Application and Dissemination for Officials*, Beijing, China, May 22-June 5, 2008, pp. 72-81.