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Full Length Research paper

Comparative Nutritional and Mineral Analysis of Cultivated and Wild Edible Mushrooms from Central Malawi

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The production of cultivated mushrooms and utilization of both cultivated and indigenously grown edible mushrooms have been on the increase in modern times especially due to their nutritional importance. A comparative study on the selected nutrient and mineral contents of two cultivated and two indigenously grown edible mushrooms were carried out at Bunda College of Agriculture in Lilongwe, Malawi between the month of June and December, 2008. Nutrient and mineral content determinations were carried out for two edible indigenous mushrooms namely *Cantharellus cibarius* and *Termitomyces letestui* and two cultivated mushrooms namely *Agaricus bisporus* and *Pleurotus florida*. Results on the selected nutrients and minerals namely protein, fat, fibre, calcium, iron and magnesium revealed both significant differences and similiarities. The indigenously grown mushroom species *C. cibarius* and *Termitomyces letestui* were found to contain 1.9 and 3.9% for protein, 0.2 and 0.7% for fat and 6.1, 2.0, 9.0 and 5.6, 1.0, 8.6% for calcium, iron and magnesium, respectively on wet basis while the cultivated mushrooms *A. bisporus* and *P. florida* were found to contain 3.0 and 2.3% for protein, 0.8 and 0.2% for fat, 2.2 and 0.2%, 8.4 and 2.8%, 0.2 and 8.0% for calcium, iron and magnesium, respectively on wet basis. It can be concluded that significant differences in selected nutrient contents exist between indigenously grown and cultivated mushroom species.

Key words: *Agaricus bisporus, Cantharellus cibarius, Pleurotus florida, Termitomyces letestui,* nutrient content, wet basis.

INTRODUCTION

Mushrooms have been used as food and medicine in many parts of the world since time immemorial. Although mushrooms are often grouped with vegetables and fruits, they are actually fungi. They are macro-fungi which belong either to Basidiomycetes or Ascomycetes and they are very distinct from plants, animals and bacteria (Mushigeni and Chang, 2001). It is evidently clear that the growing interest in the cultivation of mushrooms can help in solving many problems of global importance such as protein shortage as well as improving the health and well being of people, considering that mushrooms are valuable health foods which are low in calories and provide essential minerals.

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In most rural African village communities, indigenous edible mushrooms are highly treasured (Weinheim, 2006) since they start growing soon after the first rains and become very handy vegetables long before the agricultural crops planted are ready for harvesting (Chipompha, 1985). Nutritionally, edible mushrooms provide essential nutrients and contribute significantly to man's diet. Many studies on nutrient determination have revealed that mushrooms contain substantial amount of essential nutrients like proteins as reported by Olila et al. (2008) who found out that protein content on dry weight basis can be as high as 25.8% as determined in *Termitomyces microcarpus*. Additionally, other results have also shown that nutrient contents with respect to specific nutrients can significantly differ in mushrooms of same genus as evidenced by a study conducted by Kansci et al. (2003) who found out that the protein con-tent in six *Termitomyces* species ranged from 15 - 19%

on dry weight.

Despite the many studies on nutrients and minerals determination in different mushroom species globally, little or no work has been carried out in Malawi to compare the nutritive value between cultivated and indigenous mushrooms and this work aims at determining and comparing selected nutrients in some cultivated and indigenous edible mushrooms in Malawi.

MATERIALS AND METHODS

Sample collection and identification

Two indigenously grown edible mushrooms namely *Termitomyces letestui* and *Cantharellus cibarius* mushrooms were purchased from Lilongwe city market during the months of July to September, 2008 while two cultivated mushrooms namely *Pleurotus florida* and *Agaricus bisporus* were purchased from mushroom project at Bunda College and the local super markets within Lilongwe city respectively. Only fresh samples were purchased and no systematic sampling was done and the selection of the mushroom samples to be used in the study was based on the freshness of the samples. The purchased samples were placed on cooler boxes and immediately transferred to laboratories and identification of the mushroom species was done with assistance from the Department of Biology at Chancellor College.

Sample preparation

Prior to nutrient analysis, moisture content for each of the mushroom samples were determined using a Gallenkamp Hot box oven with fan size 2 set at 105°C until constant weights were obtained. The rest of the samples were then cleaned and washed with deionised water to remove any adhering contaminants. The cleaned samples were dried to constant weights and then ground into powder using a mini mill for further analysis.

Moisture content determination

A 2 g sample from each of the four types of the mushrooms used in the study was oven dried at 105°C to constant weights. The difference between the weight of the sample before drying and after drying was used to calculate the percentage moisture content. Three replications were done for each sample.

Ash determination

A 2 g sample from the finely ground mushroom was placed in a crucible and converted into ash at 550 - 600°C for 5 h in a carbolite muffle furnace after which it was allowed to cool in a dessicator. The difference in the weight of the crucible without the sample before and after ashing was used to calculate the ash content. There were three replications for each sample.

Wet ashing for determination of calcium, magnesium and iron

All mineral assays were made after wet ashing the samples. A 2.5 g dry ground sample from each mushroom variety was weighed and wetted afterwards with few drops of distilled water in a conical flask. 25 ml nitric acid was added and heated for 40 min and thereafter 10 ml per chloric acid was added after cooling and heated again until white fumes appeared. 50 ml of distilled water were added after cooling to precipitate the remaining nitric acid after which the contents were transferred into a 250 ml volumetric flask and filled to the mark with distilled water.

Calcium and magnesium determination

5 ml of the aliquot were placed in a titration flask using a pipette and diluted to 100 ml with distilled water and subsequently 15 ml of buffer solution, ten drops of Eriochrome black T indicator and 2 ml of triethanolamine were added. The mixture was titrated with Ethylene-Diamine-Tetra-Acetate (EDTA) solution from red to clear blue. The minerals were calculated using the formula:

$$\text{(Mg+Ca) as } CaCO_3 = \frac{M_{EDTA} \cdot V_{EDTA} \cdot rfm(CaCO_3)}{Volume}$$

Where:

M_{EDTA} = Concentration of EDTA solution;
V_{EDTA}= Volume of EDTA used in titration;
rfm = relative formula mass.

The individual minerals for example calcium were calculated using the subtraction method as shown below:

$$Ca = \frac{M_{EDTA} \cdot V_{EDTA} \cdot rfm(CaCO_3)}{Volume} - \frac{M_{EDTA} \cdot V_{EDTA} \cdot rfm(Mg)}{Volume}$$

Iron determination

The aliquot was passed through the atomic absorption spectrophotometer to read the iron concentration. Standards were prepared with a standard stock of 10 mg/L using ferrous ammonium sulphate where 3 - 60 ml of iron standard solution (10 mg/L) were placed in stepwise volumes in 100 ml volumetric flasks. 2 ml of hydrochloric acid were added and then brought to the volume with distilled water. The concentration of iron in the aliquot was measured using the atomic absorption spectrophotometer in mg/L. The whole procedure was replicated three times.

Crude fibre determination

Crude fibre was determined using a Hennenberg-Stohmann method. A 2 g sample from each of the four mushroom species was boiled in antifoam solution (1-octanol) for 30 min. Pyrex glasses were used to filter the solution where the residues were thoroughly washed with boiling water (3 times) to remove hydrochloric acid. The Pyrex glasses containing the residues were dried at 100°C for five hours, cooled to room temperature and then weighed. The crucibles were then placed in a muffle furnace at 555°C for 5 h, cooled to room temperature and then reweighed to find the fibre content percentage.

Protein determination

Crude protein was determined by Kjeldahl method. A 0.5 g ground sample from each of the mushroom species was digested in Kjeldahl flask using 98% sulphuric acid after which it

Table 1. Moisture, crude protein, fibre and fat contents of the cultivated and indigenous mushrooms (g / 100g).

Mushroom species	Moisture	Protein	Fat	Fibre
A. bisporus	91.6 ± 1.6^{b}	3.0 ± 0.1^{b}	0.8 ± 0.0^{a}	0.5 ± 0.0^{a}
C. cibarius	91.5 ± 0.7^{b}	1.9 ± 0.1^{c}	0.2 ± 0.0^{b}	0.5 ± 0.0^{a}
P. florida	91.7 ± 1.6^{b}	2.3 ± 0.1^{d}	0.2 ± 0.0^{b}	0.2 ± 0.0^{b}
T. letestui	88.0 ± 2.0^{a}	3.9 ± 0.1^{a}	0.7 ± 0.1^{a}	0.5 ± 0.0^{b}

Table 2. Calcium, iron and magnesium contents of the cultivated and indigenous mushrooms (mg/100 g).

Mushroom species	Calcium	Iron	Magnesium
A. bisporus	2.2 ± 0.1^{b}	0.2 ± 0.0^{a}	8.4 ± 0.1^{a}
C. cibarius	6.1 ± 0.2^{c}	2.0 ± 0.0^{c}	9.0 ± 0.3^{b}
P. florida	2.8 ± 0.1^{d}	0.2 ± 0.0^{a}	8.0 ± 0.1^{c}
T. letestui	5.6 ± 0.2^{a}	1.0 ± 0.0^{b}	8.6 ± 0.2^{a}

was steam-distilled. The resulting distillate was titrated to pink or wine-red colour using 0.01 M hydrochloric acid and the protein percentage was calculated using the formula as shown:

$$\%\text{Protein content} = \frac{(N \cdot 14.007 \cdot (Vs - Vb) \cdot 6.25 \cdot 50) \cdot}{100\ W \cdot 1000}$$

Where:

N = normality (0.01) of standard HCl acid;
Vs = volume of standard HCl acid used to titrate a sample;
Vb = volume of standard HCl acid used to titrate a blank.
W = weight (g) of dry sample used.

Fat determination

Crude fat was determined using Soxhlet extraction apparatus. Petroleum ether (boiling point equals 40 - 60°C) was added to a 2.0 g finely ground mushroom sample placed in the extraction apparatus. Extraction was carried out for 16 h after which the ether was evaporated to dryness. The amount of fat was obtained from the difference in the weight of the flask and after drying of the ether.

Data analysis

All data obtained from the study were analysed using GenStat discovery edition 3 computer package and were subjected to one-way analysis of variance (ANOVA). Differences in the nutritive values for the four mushroom species used in the study were evaluated using least significance difference test at 5% level of significance.

RESULTS AND DISCUSSION

Results on moisture, crude protein, crude fat and crude fibre contents have been presented in Table 1 while calcium, iron and magnesium contents of the indigenous and cultivated mushroom species are presented in Table 2. All the nutrient and mineral contents have been presented on wet basis. Comparison on different nutrients among the mushroom samples were not made based on mushroom genus and specie because all the four mushroom samples used in the study belonged to different mushroom genuses and species. Results on moisture content showed that the values ranged from 88.8 - 91.7% and this was comparable to the results as reported by Weinheim (2006). Although variability may be exclusively dependent on mushroom species, other interfering parameters such as post harvest period, temperature and relative humidity during growth may also contribute to such differences. Results revealed significant differences in moisture content between *T. letetsui* and the three other mushroom species namely *A. bisporus, C. cibarius* and *P. florida* (Table 1). Results on crude protein, crude fat and crude fat contents in the four mushroom species used in the study showed inconsistencies with respect to the level of significance. Protein content was significantly different in all the four mushroom species (Table 1) and the values obtained were similar to those reported by Chang and Miles (1969) who found out that protein content in mushrooms vary from species to species but within the range of 1.75 - 5.9% on wet basis but has been estimated that an average value of 3.3 - 4.0% would be more representative. Higher protein contents were found in indigenously grown *T. letetsui* followed by the cultivated *A. bisporus* (Table 1). The protein and fat contents for *A. bisporus* were discovered to be comparable to those as found by Caglarlrmak et al. (2002) who reported 3.10 and 0.80% for protein and fat, respectively. The results on protein, moisture and fat contents for *A. bisporous* were slightly different from the

ones reported by Colak et al. (2009) who reported 87.9, 34.17 and 1.40% for moisture, protein and fat contents, respectively. However, results on crude fat were found to be significant when *A. bisporus and T. letetsui* were compared with *C. cibarius* and *P. florida* and the results were similar with those reported by Agrahar-Murugkar and Subbulakshmi (2005) who found that for different mushroom species, the range was between 0.2 - 0.98 g / 100 g on wet-weight basis. There were no significant differences in fibre content among *T. letetsui*, *C. cibarius* and *A. bisporous, a*lthough the fibre content in the three types of mushrooms was significantly different ($P < 0.05$) with the values for *P. florida* mushrooms. Differences in the nutrient contents for the same mushroom species by different authors may be attributed to a wide range of reasons such as different climatic conditions, growing conditions, region as well as post handling conditions which may affect parameters like moisture content. Significant differences were observed in calcium contents in all four mushroom species with higher values obtained in the indigenous mushroom species (Table 2). Results on iron content in the cultivated mushroom species showed no significant differences while there were significant differences in indigenous mushrooms and values were higher than those in cultivated mushroom species. The results on iron content for *C. cibarius* were lower than the ones reported by Colak et al. (2009). However, results on magnesium content showed that all the four mushroom species contained considerable amounts (Table 2) and values obtained were significantly different in certain instances with no differences observed when *A. bisporus* was compared with *T. letetsui*.

Conclusion

Results from the study have clearly shown that all the four mushroom species used in the study contained considerable amount of proteins and minerals which are vital in supplementing nutrition to mankind. It can therefore be concluded from the study that differences and similarities in nutritive contents with respect to protein, fat, fibre, calcium, iron and magnesium in the four mushroom species namely *A. bisporus*, *C. cibarius*, *P. florida* and *T. letetsui* do exist. However, from the study it was not possible to assess the nutritional supre-macy between cultivated and indigenous mushroom mushroom species. It was also evidently clear that comparisons of nutrients based on genus and specie was not possible because the four mushroom species belonged to different genuses and species. It is highly recommended that future studies on the comparative study in nutrient contents between cultivated and in-digenously grown mushroom species should include more species considering that there are more in-digenous and cultivated mushroom species in different locations of the world.

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