VERSITA 10.2478/auoc-2013-0008
Ovidius University Annals of Chemistry Volume 24, Number 1, pp.39-42, 2013

Trace element levels of three mushroom species

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Abstract The aim of this study was to determine Cu, Fe and Cr contents of three species of fresh mushrooms and canned mushrooms: white and brown champignon (*Agaricus bisporus*) and *Pleurotus Ostreatus*. Were analyzed various plant parts: stem, cap and cuticle of fresh mushrooms and only stem and cap for canned mushrooms. The levels of trace metals of mushroom samples collected from regions of Romania, Poland and Turkey were determined by UV/Visible spectrometry - standard addition method after digestion method. The contents of investigated trace metals in mushroom samples were found to be in the range of 0.01 – 2.26 mg/Kg for chromium, 2.02 – 430.67 mg/Kg for copper and 240.40 – 7952.89 mg/Kg for iron. The iron content was found to be higher than those of the other two minerals in all the samples. Mushrooms species in the highest levels of trace elements were found white champignon for Cu and Fe and brown champignon for Cr.

Keywords: Cu, Fe, Cr, mushrooms, UV/VIS spectrometry.

1. Introduction

The heavy metal pollution represents a significant environmental problem arising from its toxic effects and accumulation throughout the food chain. Accurate and adequate food composition data are invaluable for estimating the adequacy of intakes of essential nutrients and assessing exposure risks from intake of toxic non-essential heavy metals.

Mushrooms have been reported as therapeutic foods, useful in preventing diseases such as hypertension, hypercholesterolemia and cancer. These functional characteristics are mainly due to their chemical composition [1, 2].

Mushrooms are valuable healthy and nutritious foods, good source of quality protein, minerals and vitamins, low in calories and have been relished as a delicacy for centuries because of their subtle flavor, nice aroma and physical taste appeal [3-5].

Copper is an essential metal for normal plant growth and development, although it is also potentially toxic. For humans copper is an essential nutrient that plays a role in the production of hemoglobin (the main component of red blood cells), myelin (the substance that surrounds nerve fibers), collagen (a key component of bones and connective tissue), and melanin (a dark pigment that colors the hair and skin). The RDA (Recommended Dietary Allowance) for copper - is 900 micrograms a day for both men and women.

Iron is critical for cholorphyll formation and photosynthesis. Iron is also used by enzymes to regulate transpiration in plants. For humans, iron is a mineral present in certain enzymes and hemoglobin, the substance in red blood cells that enables the blood to transport oxygen throughout the body. The RDA for iron for the adult male is 10 mg/day, while that for the adult woman is 15mg/day [6, 7].

Chromium can be considered even a trace element, but in excessive dose is a toxic for health. Toxicity of Cr depends on its valence state: Cr(VI) is highly toxic and mobile whereas Cr(III) is less toxic [8, 9].

Mushrooms can build up large concentrations of some heavy metals, such as lead, cadmium and mercury, and a great effort has been made to evaluate the possible danger to human health from the ingestion of mushrooms [10-13].

ISSN-1223-7221

The aim of this study was to determine Cu, Fe and Cr contents of three species of fresh and canned mushrooms.

2. Experimental

2.1. Reagents and solutions

The working solutions were prepared by diluting the stock solutions to appropriate volumes. All reagents were of analytical-reagent grade and all solutions were prepared using deionised water.

2.2. Sample preparation

Studied samples in this paper were white and brown champignons (*Agaricus bisporus*) from Romania and Poland (fresh and canned mushrooms) and from Turkey (fresh mushrooms) and *Pleurotus Ostreatus* (fresh mushrooms). Were analyzed various mushroom parts: stem, cap and cuticle of fresh mushrooms and only stem and cap for canned mushrooms.

The determination of the total metal concentration in the investigated samples was done after sample mineralization step using a Digesdahl device.

2.3.Sample analysis

Standard addition was the method used to determinate the Cu, Fe and Cr concentration in mushroom samples.

Ammonia is a very sensitive reagent used in the analysis of copper. The method is based on the reaction of Cu (II) with ammonia and spectrometric determination of the complex $[Cu\ (NH_4)]^{2+}$, using two solutions: A and B.

Solution A:

- In a 50 mL volumetric flask, 5 mL sample and 2.5 mL ammonia were added and the volume was diluted with distilled water;
- the absorbance was read at 600 nm at the DR 2000 spectrometer using a reference solution (distilled water).

Solution B:

- In another flask, 5 mL sample solution, 2 mL standard Cu (II) reagent and all reagents from A solution in the presented order were added;
- Solution B absorbance was read against distilled water.

For iron determination have been prepared two solutions A and B. Solution A contains only unknown sample and solution B unknown sample and a measured volume of standard solution of Fe (II).

Solution A:

- In a 50 mL volumetric flask, 2 mL sample, 5 mL sodium acetate and 5 mL of hydroxylamine hydrochloride were added and were shaked for mixing;
- after 5 minutes were added 5 mL of 1.10 phenanthroline reagent;
- after 10 minutes for stabilizing color, the volume was diluted with distilled water;
- the absorbance was read at 510 nm at the DR 2000 spectrometer using a reference solution (distilled water).

Solution B:

- In another flask, 2 mL sample solution, 2 mL standard Fe (II) reagent and all reagents from A solution in the presented order were added;
- Solution B absorbance was read against distilled water.

For Cr determination two solutions A and B have been prepared. Solution A contains only unknown sample and solution B unknown sample and a measured volume of standard solution of Cr (VI). The method is based on the determination of total chromium in form of Cr (VI) with 1.5 diphenylcarbazide after complete oxidation of Cr (III) to Cr (VI) with H_2O_2.

Solution A:

- In a 50 mL volumetric flask, 5 mL sample, 0.5 mL H_2O_2, 0.2 mL H_2SO_4 and 2 mL of 1.5 diphenylcarbazide were added and were shaked for mixing;
- the volume was diluted with distilled water;
- the absorbance was read at 540 nm at the DR 2000 spectrometer using a reference solution (distilled water).

Solution B:

- In another 50 mL volumetric flask, 5 mL sample solution 1 mL standard $K_2Cr_2O_7$ solution and all reagents from A solution in the presented order were added;
- Solution B absorbance was read against distilled water.

3. Results and Discussions

The results of trace metals determination are presented in **Tables 1-6.**

Table 1. The content of Cu in fresh mushroom samples, mg/kg (mean ± SD)

Samples		Stem	Cup	Cuticle
White Agaricus bisporus	Romania	12.3± 0.6	15.7± 0.8	38.7± 2.3
	Poland	123± 6.1	130.7± 9.1	203.3± 10.1
	Turkey	89.6± 4.9	20.3± 1.2	460.3± 27.6
Pleurotus		37.6± 2.6	8.9± 0.4	36.7± 2.6
Brown Agaricus bisporus		2± 0.1	96.6± 5.7	292.2± 17.5

Table 2. The content of Cu in canned mushroom samples, mg/kg (mean ± SD)

Samples		Stem	Cup
White Agaricus bisporus	Romania	48.4±2.4	53.2±3.7
	Poland	134.7±7.4	165.2±8.2

The largest amount of copper was found in cuticle of white mushroom from Turkey. White mushrooms has a higher concentration of copper than brown. Copper concentration ranges from 2.02 to 460.37 mg/kg. Literature were reported copper concentrations ranging from 6.20 to 480 mg/kg [13]. In all samples analyzed copper concentration was comparable to that reported in the literature. From Tables 1 and 2 it was observed that the concentration levels of copper in canned mushrooms were higher than copper concentrations in fresh mushrooms.

Table 3. The content of Fe in fresh mushroom samples, mg/kg (mean ± SD)

Samples		Stem	Cup	Cuticle
White Agaricus bisporus	Romania	240.4± 14.4	320.2±16.1	7952.8± 477.1
	Poland	272.2± 13.6	529.1±31.7	1553.5± 124.2
	Turkey	1220.4± 109.8	420.4±21.1	6718.1± 470.2
Pleurotus		561.1± 28.1	652.7±39.1	2207± 110.3
Brown Agaricus bisporus		1561.5± 78.1	1470.8±88.2	5950.1± 357.1

The highest concentration of total iron was found in white Romania mushroom cuticle. Iron concentration has ranged between 240.4 to 7952.8 mg/kg. In the literature have been reported iron concentrations ranging from 56.1 to 7162 mg/kg [13].

Table 4. The content of Fe in canned mushroom samples, mg/kg (mean ± SD)

Samples		Stem	Cup
White Agaricus bisporus	Romania	240.4±19.2	320.2±25.6
	Poland	272.2±16.3	529.1±37.1

Table 5. The content of Cr in fresh mushroom samples, mg/kg (mean ± SD)

Samples		Stem	Cup	Cuticle
White Agaricus bisporus	Romania	0.030± 0.002	0.20± 0.01	1.30± 0.07
	Poland	0.100± 0.008	0.20± 0.01	0.080± 0.004
	Turkey	0.100± 0.007	0.100± 0.005	0.080± 0.007
Pleurotus		0.0100± 0.0009	0.100± 0.006	1.8± 0.1
Brown Agaricus bisporus		0.30± 0.01	0.40± 0.02	2.2± 0.1

Table 6. The content of Cr in canned mushroom samples, mg/kg (mean ± SD)

Samples		Stem	Cup
White Agaricus bisporus	Romania	0.100 ± 0.007	0.20 ± 0.01
	Poland	0.100 ± 0.006	0.4 ± 0.03

The largest amount of chromium was found in Pleurotus cuticle. The smallest quantity of chromium was found in white Romania mushroom stem. Chromium concentration has values between 0.011 to 2.26 mg/kg. Literature were reported concentrations ranging from 0.3 to 10.88 mg/kg [10, 13]. Analyzed samples are lower chromium concentrations with those reported in the literature. From Tables 5 and 6 it was observed that the concentration levels of chromium in canned mushrooms were higher than chromium concentrations in fresh mushrooms.

4. Conclusions

Analyzed mushroom species contain appreciable quantities of Fe, Cu and Cr. Champignon brown variety has a higher amount of chromium in comparison with white Pleurotus variety. Champignon white mushrooms have a higher copper concentration than brown. Variety of white Romanian champignon has the lowest concentration of copper in comparison with other countries. Brown mushrooms have a higher concentration of iron than white, except cuticle species in Romania.

The concentrations of copper, chromium and total iron in canned mushrooms are higher than in fresh mushrooms probably due to accumulation of metals in tin case.

5. References

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[1]. Y.K. Bayhan, B. Keskinler, A. Cakici, M. Levent and G. Akay, Water Res., **35** (9), 2191 (2001).
[2]. M. Tuzen, E. Sesli and M. Soylak, Food Control, **18**, 806 (2007).
[3]. S.M. Sabir, I. Hayat, I. Hussain and S.R. Ali, Pakistan Journal of Plant Pathology **2**(2), 97 (2003).
[4]. P. Ouzouni and Riganakos K.A., Acta Alimentaria **36**, 99 (2007).
[5]. P. Ouzouni, P.G. Veltsistas, E. Paleologos and K.A. Riganakos, Journal of Food Composition and Analysis **20**(6), 480, (2007).
[6]. Y. Inmaculada, Braz. J. Plant Physiol. **17**, 1 (2005)
[7]. R. Anthony Brach, "Critical for chlorophyll formation and photosynthesis. Important in enzyme systems and respiration in plants." http://www.agric.gov.ab.ca/agdex/500/531-3.html
[8]. A. K. Shanker, C. Cervantes, H. Loza-Tavera and S. Avudainayagam, Environment International **31**(5), 739 (2005)
[9]. A. Soceanu, S. Dobrinas, V. Popescu, S. Birghila and V. Magearu, Ovidius University Annals of Chemistry, 17(1), 79 (2006)
[10]. D. Mendil, O. D. Uluozlu, E. Hasdemir and A. Caglar, Food Chemistry **88**, 281 (2004).
[11]. A. Demirbas, Food Chemistry **74**, 293 (2001).
[12]. H. Genccelep, Y. Uzun, Y. Tuncturk and K. Demirel Food Chemistry, **113,** 1033 (2009)
[13]. M. Yamaç, D. Yildiz, C. Sarikürkü and M. Çelikkollu Food Chemistry, **10**, 263 (2007).

Submitted: April 17th 2013
Accepted in revised form: May 11th 2013