METALLIC ELEMENTS IN THE FRUITING BODIES OF FLY AGARIC *AMANITA MUSCARIA* (L.: FR.) PERS. COLLECTED FROM VARIOUS SITES IN POLAND

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Abstract

The concentrations of some trace elements (such as Fe, Ag, Zn, Mn, Cu, Cd, Mg, Ca, Na, K) were determined in the fruiting bodies of Fly Agaric *Amanita muscaria* (L.: Fr.) Pers. The mushrooms were collected in Poland in 1999 and 2000. The samples of dried and pulverized mushrooms (separately the caps and the stalks) were wet digested with concentrated nitric acid in PTFE vessels under pressure in an microwave oven. The elements were quantified using atomic emission spectroscopy with induced coupled plasma (ICP-AES). There were some variations of trace elements content depending on the site of collection. This fact can be explained by different biota conditions and different composition of soil in various regions of Poland. The sodium, potassium, magnesium and calcium are typical essential elements for different biota and these metals were usually found in higher concentrations than silver and cadmium. Almost for all quantified elements the concentrations were greater in caps then in stalks. The concentrations of cadmium, copper, zinc, magnesium, calcium and potassium in fly agaric *Amanita* muscaria (L.: Fr.) were more or less the same in all investigated sites in Poland.

Introduction

The presence of high amounts of some elements, especially high toxic such as mercury, lead and cadmium can be treated as a potential danger for human health and for environment. These elements get to the environment from various sources i.e.: from industry, agriculture, transport and communication. Many of them have ability to accumulate in different parts of natural environment and in trofic chains. Organisms take these metals in various ways i.e.: from air, from food and water and in the case of plants from soil. Often the presence of these elements is necessary for proper functioning of plant or animal organism. But in some cases (selenium) there are small differences between toxic and necessary level of some elements. That's why it is very important to control the amount of heavy metals delivered to environment from anthropogenic sources.

Mushrooms are very good organisms for studies about occurrence of heavy metals in environment because they have capacity for accumulation of some elements. Additionally mushrooms are present almost in all kinds of the ecosystems.

The contamination of mushrooms with heavy metals depends on many factors including species of mushrooms and level of soil contamination where the mushroom grows. It is known that some species of mushrooms even when grown at the regions

considered as unpolluted can contain in their flesh some metals in a large concentrations (1,2). These organisms can also be useful as an indicator of environmental pollution in future research.

Materials and methods

The samples of mushrooms from *Amanita muscaria* genus were collected at various sites in Poland such as: Lubelska Upland, Tucholskie Forest, Nadwarciańskie Forest, community of Morąg, area of cities: Starachowice, Bydgoszcz and Włocławek. All samples were collected in years 2000-2002. There were about sixteen subsamples for each sample. The fresh fruiting bodies, separately caps and stalks, after clean–up from any foreign plant material and soil with plastic knife were dried for several days in the air and then further dried in an oven at 30º and powdered in an agate mortar. Around of 0.5 g of dried material was wet digested with 6 ml of concentrated HNO_3 under pressure in PTFE vessels in a microwave oven (Mars 5, CEM). The concentrations of elements (Fe, Ag, Zn, Mn, Cu, Cd, Mg, Ca, Na, K) were measured by atomic emission spectrometry with inductively coupled plasma (ICP-AES, Optima 2000, Perkin-Elmer). The method was validated using CTA-OTL-1 certified reference material.

Results and discussion

The concentrations of ten elements: Ag, Zn, Mn, Cu, Cd, Fe, Mg, Ca, Na, K were determined in mushroom *Amanita muscaria* collected from various sites in Poland. The results are in tables 1 to 4. Almost for all quantified elements the concentrations were greater in caps then in stalks (except sodium and manganese). The highest concentrations were measured for elements such potassium, calcium, magnesium. These are typical essential elements for different groups of organism. The smallest values were obtained for elements with some toxic abilities such silver and cadmium. There were some variations of trace elements content depending on the site of collection. Area of Włocławek is the site with lowest concentrations of such elements as: Ag, Cd, Cu, Fe, Ca. In the case of sodium this area have highest values both for caps and stalks (160±91 µg/g dry matter in caps and 530±270 µg/g dry matter in stalks). The highest amounts of zinc were measured for area of Starachowice (220 µg/g dry matter in caps). In the case of manganese the highest concentrations were obtained for samples from Lubelska Upland and community of Morąg (42±16 µg/g dry matter in caps in Morąg and 64±45 µg/g dry matter in stalks in Lubelska Upland). For all remaining sites the concentrations of manganese were more or less the same. In samples from Community of Morąg the highest amounts of calcium were detected (290±160 µg/g dry matter) . Concentrations of such elements as: silver, cadmium, iron, magnesium, potassium, copper and sodium were on similar levels in all sampling sites except area of Włocławek. This fact can be explained by different biota conditions and different composition of soil in various regions of Poland. The concentrations of cadmium in mushroom *Amanita muscaria* collected in Norway, Finland and Czech Republic are similar to those reported in this article (3,4,5). Also in the case of manganese, copper and potassium there are no significant differences between values reported in this study and values obtained in other European countries(3,5,6). In the case of iron the results from Germany and Turkey are higher than obtained in this studies (6, 7). There are considerable differences between concentrations reported for zinc and manganese in Turkey (7) and in this article.

Table 1. Total concentrations of some elements (Ag, Zn, Mn, Cu, Cd) in the caps of fly agaric *Amanita muscaria* (L.:) Fr. Pers. (mean±standard deviation and range in μg/g dry weight).

Site of sampling	Ag	Zn	Mn	Cu	Cd
Lubelska Upland	0.80±0.35 0.54-1.50	140±41 110-230	42±16 25-71	30±7 24-46	18±8 7.8-30
Tucholskie Forest	0.75±0.11 0.61-0.92	130±55 1.1-220	17±13 0.039-42	42±19 0.12-90	15±10 3.6-34
Nadwarcianskie Forest	0.81±0.08 0.70-088	150±57 92-260	14±5 6.4-20	48±10 39-68	20±13 9.4-41
Community of Morąg	0.46±0.06 0.39-0.60	150±36 92-190	24±5 17-31	38±9 30-53	16±6 11-28
Area of Starachowice	0.72±0.26 0.51-1.3	220±61 130-290	25±10 13-41	54±12 42-76	23±13 6.5-41
Area of Bydgoszcz	0.88±0.18 0.68-1.1	180±34 140-240	17±4 10-23	42±5 36-50	20±6 8.7-25
Area of Włocławek	0.62±0.04 0.57-0.70	150±21 120-170	11±3 8.4-16	38±8 26-48	13±4 7.7-18

Table 2. Total concentrations of some elements (Fe, Mg, Ca, Na, K) in the caps of fly agaric *Amanita muscaria* (L.:) Fr. Pers. (mean±standard deviation and range in μg/g dry weight).

Site of sampling	Fe	Mg	Ca	Na	K
Lubelska Upland	240±72 160-350	940±92 840-1100	120±31 72-170	35±13 22-56	40000±5300 35000±50000
Tucholskie Forest	240±120 0.09-440	960±180 680-1400	96±50 45-210	44±22 12-84	45000±6800 33000-55000
Nadwarcianskie Forest	180±100 67-320	940-110 810-1100	71±36 25-130	90±79 22-260	41000±5000 36000-50000
Community of Morąg	200±60 130-280	1000±130 900-1200	290±160 120-630	38±17 19-70	53000±9700 38000-66000
Area of Starachowice	170±60 87-260	980±66 880-1100	110±33 58-170	48±24 29-99	42000±2000 39000-45000
Area of Bydgoszcz	240±110 85-430	1100±130 910-1300	180±69 92-250	33±7 21-41	42000±5900 35000-51000
Area of Włocławek	71±28 35-120	780±76 680-870	75±36 41-140	160±91 41-260	34000±3200 29000-39000

Table 3. Total concentrations of some elements (Ag, Zn, Mn, Cu, Cd) in the stalks of fly agaric *Amanita muscaria* (L.:) Fr. Pers. (mean±standard deviation and range in μg/g dry weight).

Site of sampling	Ag	Zn	Mn	Cu	Cd
Lubelska Upland	0.37±0.13 0.22-0.54	91±22 61-130	45±30 16-110	7.9±2.4 5.6-12	5.7±2.4 2.9-9.6
Tucholskie Forest	0.46±0.30 0.086-0.86	83±31 42-140	32±13 14-58	17±8 7.6-38	4.3±5.1 0.6-13
Nadwarcianskie Forest	0.71±0.29 0.39-1.2	100±51 56-190	19±10 8.9-35	16±5 8.5-25	8.9±6.8 2-20
Community of Morąg	0.26±0.20 0.038-0.53	110±30 86-150	64±45 13-140	15±5 9.8-24	8.4±5.7 3.7-19
Area of Starachowice	0.61±0.14 0.40-0.87	110±25 83-160	22±6 16-33	23±6 15-35	9.4±4.6 4.4-17
Area of Bydgoszcz	0.87±0.13 0.71-1.1	130±35 95-190	11±3 7-17	17±4 13-23	8.8±4.3 4.5-17
Area of Włocławek	0.63±0.16 0.43-0.89	100±16 77-130	4.8±0.7 3.8-5.6	15±2 11-18	4.5±1.9 2.5-7.3

Table 4. Total concentrations of some elements (Fe, Mg, Ca, Na, K) in the stalks of fly agaric *Amanita muscaria* (L.:) Fr. Pers. (mean±standard deviation and range in μg/g dry weight).

Site of sampling	Fe	Mg	Ca	Na	K
Lubelska Upland	280±130 78-460	380±52 330-450	130±33 75-170	150±91 140-340	19000±2200 17000-24000
Tucholskie Forest	1100±1000 110-2800	480±75 330-640	190±87 81-370	150±81 78-380	27000±12000 12000-45000
Nadwarcianskie Forest	230±48 160-300	500±100 360-630	110±46 63-190	130±110 30-340	27000±9100 16000-43000
Community of Morąg	880±680 110-1800	730±100 590-880	390±130 230-630	210±260 38-780	34000±7400 22000-44000
Area of Starachowice	110±76 53-270	620±130 540-910	110±40 57-160	250±180 28-550	30000±6800 19000-41000
Area of Bydgoszcz	100±29 56-140	600±45 570-690	170±85 99-330	91±39 23-150	38000±4100 32000-44000
Area of Włocławek	66±31 26-120	370±27 330-410	51±12 35-70	530±270 110-820	24000±2400 20000-26000

Conclusions

The mushroom *Amanita muscaria* has some ability to concentrate elements. The highest values of concentrations were determined for potassium, magnesium and calcium. In the case of cadmium the concentrations were much smaller but *Amanita muscaria* cumulate this element in higher degree as other species of mushrooms [1,3,4,5]. Almost for all quantified elements the concentrations were greater in caps then in stalks (except sodium and manganese). Also there are some differences with trace elements content depending on the sampling site.

References

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