Food Chemistry 254 (2018) 256–259

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Heavy metal contaminations in edible wild mushroom species from Turkey's Black Sea region

Mustafa Türkmen*, Derya Budur

Giresun University, Faculty of Science & Arts, Department of Biology, 281000 Giresun, Turkey

ARTICLE INFO

Keywords:
Heavy metals
Risk assessment
Wild edible mushroom
Intakes
Turkey

ABSTRACT

The present study examined heavy metal contamination in six edible wild mushroom species obtained from twenty-one stations in Turkey's Black Sea region. Heavy metals were analyzed ICP-MS. Concentrations of cadmium, cobalt, chromium, copper, iron, manganese, nickel, lead and zinc were measured in the ranges of 0.08–3.37, 0.01–2.50, 0.36–6.26, 17.5–122, 97.2–3919, 4.61–102, 12.7–24.2, 0.15–1.80 and 34.4–225 mg/kg, respectively. The highest metal was iron in all of the examined species from the stations; and differences among metal levels across all of stations were found to be statistically significant ($p < 0.05$). Moreover, the maximum provisional tolerable weekly intake limits for edible mushroom species was calculated and assessed for the purpose of human health.

1. Introduction

Mushrooms are rich in protein, as well as play an important role in the ecosystem. They are low calorie food source, are rich in various vegetable proteins, minerals and vitamins (Racz, Papp, Prokai & Kovacz, 1996). Mushrooms are responsible for the breaking down of a considerable quantity of organic matter, and play an important part in cycle of nature. They also are very effective when it comes to accumulating heavy metals from polluted environments. This therefore means that mushrooms can be used in order to evaluate environmental pollution levels (Sesli & Tüzen, 1999). Nickel, cadmium, lead, iron, manganese, copper, cobalt, and zinc were selected in this study as they represent a reliable index of environmental pollution. Metals such as iron, copper, zinc and manganese which have important role in biological systems are essential. But metals such as lead and cadmium are toxic even in traces and non-essential (Schroeder, 1973). Considering that wild mushrooms are a major part of the human diet in various country and cultures, a large number of studies have been performed on heavy metal contamination in different wild mushrooms (Tüzen, 2003; Tüzen, Turkekul, Hasdemir, Mendil & Sarı, 2003; Radulescu, Stihi, Busuioc, Gheboianu & Popescu, 2010; Zhu, et al., 2011; Liu, et al., 2015). Turkish studies on mushrooms are inadequate despite Turkey's considerable (and especially recent) potential as a producer of edible wild mushroom species. The present study tested the level and extent of heavy metal contaminations in edible wild mushroom species found in Turkey's Black Sea region, using ICP-MS and microwave digestion.

2. Materials and methods

Species were obtained from twenty-one stations across Turkey's Black Sea region between June and September of 2014. The studied species, the number of samples, stations and coordinates have been presented in Table 1. Upon collection, the samples were dried at 105 °C over a 24-h period, and then homogenized and stored in polyethylene bottles prior to analysis. All of the plastic and glassware used were cleaned by means soaking, overnight in a 10% nitric acid solution, and then rinsed with deionized water. One gram of the sample was digested with 6 ml of nitric acid and 2 ml of hydrogen peroxide in a microwave digestion system (CEM MARSX, 240/50, USA). The residue was then diluted with deionized water in 10 ml volumetric flaks (Türkmen & Dura, 2016).

The samples were filtered through a 0.45 μm filter prior to analysis. Calibration standards were prepared from a multi-element standard (Merck, Darmstadt, Germany). Dorm-4 certified fish protein (National Research Council, Ontario, Canada) was used as the calibration verification standard. Percent recoveries were 93 for Ni, 104 for Cu, 113 for Cr, 102 for Zn, 91 for Cd, and 115 for Pb. Samples were analyzed three times for heavy metals using an ICP-MS (BRUKER 820-MS, Germany) as $mg.kg^{-1}$ wet weight Türkmen & Dura, 2016). The working conditions of instrument featured in this study are shown in Table 2. One-way ANOVA and Duncan's multiple range tests were performed in order to test the differences among metal levels across all of the stations ($p < 0.05$).

* Corresponding author.
E-mail address: mustafa.turkmen@giresun.edu.tr (M. Türkmen).

https://doi.org/10.1016/j.foodchem.2018.02.010
Received 15 November 2017; Received in revised form 31 January 2018; Accepted 2 February 2018
Available online 03 February 2018
0308-8146/

Table 1
Sampling stations and examined species.

Stations	Coordinates	N	Species
Fatsa (FT)	41°1.0′N 37°29′E	3	*Lactarius glyciosmus*
Ulubey (UL)	40°52′N 37°45′E	3	*Lactarius glyciosmus*
Çaka (ÇK)	41°3.0′N 37°46′E	3	*Cantharellus cibarius*
Ünye (ÜN)	41°7.0′N 37°17′E	3	*Lactarius glyciosmus*
Kumru (KM)	40°52′N 37°13′E	3	*Cantharellus cibarius*
Ordu M. (ORM)	40°59′N 37°52′E	6	*Lactarius glyciosmus, Cantharellus cibarius*
Gölköy (GK)	40°41′N 37°37′E	3	*Lactarius glyciosmus*
Akkuş (AK)	40°46′N 37°0.0′E	6	*Lactarius glyciosmus, Cantharellus cibarius*
Kabadüz (KB)	40°51′N 37°53′E	6	*Cantharellus cibarius, Lepiota procera*
Buluncak (BL)	40°55′N 38°3′E	6	*Lactarius glyciosmus, Lepiota procera*
Dereli (DR)	40°44′N 38°26′E	9	*L. glyciosmus, C. cibarius, L. volemus*
Kayadibi (KY)	40°53′N 38°23′E	9	*L. glyciosmus, C. cibarius, L. volemus*
Alınca (AL)	40°52′N 38°19′E	9	*L. glyciosmus, C. cibarius, L. volemus*
Burhaniye (BH)	40°50′N 38°8.0′E	6	*Cantharellus cibarius, Lactarius volemus*
Okçu (OK)	40°46′N 38°7.0′E	3	*Cantharellus cibarius*
Söğütönü (SÖ)	40°38′N 38°14′E	6	*Polyporus squamosus, Lactarius salmonicolor*
Kulakkaya (KK)	40°41′N 38°22′E	6	*Polyporus squamosus, Lactarius salmonicolor*
Kazankaya (KZ)	40°29′N 38°30′E	6	*Polyporus squamosus, Lactarius salmonicolor*
Ağaçbaşı (AB)	40°41′N 38°20′E	6	*Polyporus squamosus, Lactarius salmonicolor*
Tandır (TD)	40°40′N 38°6.0′E	3	*Polyporus squamosus*
Boztekke (BK)	40°54′N 38°18′E	3	*Lactarius salmonicolor*

Table 2
ICP-MS working conditions.

Parameters	Settings	Parameters	Settings
Plasma flow	18.0 (l/min)	Corner lens	−193 (volt)
Auxiliary flow	1.80 (l/min)	Left mirror lens	45 (volt)
Nebulizer flow	0.90 (l/min)	Right mirror lens	33 (volt)
Sheath gas	0.15 (l/min)	Bottom mirror lens	38 (volt)
CRI gas He	160 (ml/min)	Entrance lens	−1 (volt)
CRI gas H_2	100 (ml/min)	Fringe bias	−2.5 (volt)
RF power	1.40 (kW)	Entrance plate	−39 (volt)
Sampling depth	6.5 (mm)	Pole bias	0 (volt)
Pump rate	4 (rpm)	Scan mode	Peak hopping
Stabilization delay	15 (s)	Dwell time	20 (ms)
Spray chamber	3 (°C)	Points per peak	1
First extraction lens	−1 (volt)	Scans/Replicate	50
Second extraction lens	−180 (volt)	Replicates/Sample	3
Third extraction lens	−226 (volt)		

3. Results and discussion

All of wild mushroom species examined in the present study were edible. Concentrations of nine elements in the specimens according to the stations presented in Table 3. The differences among stations were statistically significant ($p < 0.05$). The metal with the highest concentration was iron, whilst the metal with the lowest concentration was cobalt. Here, it should be mentioned that many researchers have revealed similar results (Tüzen, 2003; Yamaç, Yıldız, Sarıkürkçü, Çelikkollu & Solak, 2007; Zhu et al. 2011). The lowest level of cadmium was found in the AK station, measuring as 0.08 mg/kg, whilst the highest level of cadmium was measured as 3.37 mg/kg at the AL station. The lowest level of cobalt was measured as 0.01 mg/kg at the UL station; whereas the highest level was measured as 2.50 mg/kg in the KB station. The lowest and highest levels of chromium were measured as 0.36 and 6.26 mg/kg at the KK and ÜN station respectively. The lowest level of copper was measured as 17.5 mg/kg at the ÜN station, whereas highest level was measured as 122 mg/kg at the KB station. The lowest and highest levels of iron were measured as 97.2 and 3919 mg/kg at the UL and KB stations respectively. The smallest and largest concentrations of manganese were measured as 4.61 and 102 mg/kg at the UL and KB stations. The lowest level of nickel was measured as 12.7 mg/kg at the ÜN station, whereas the highest level was measured as 24.2 mg/kg at the UL station. The lowest level of lead was detected and measured as 0.15 mg/kg at the UL station, whilst highest level was measured as 1.80 mg/kg at the KB station. Finally, the smallest and greatest concentrations of zinc were measured as 34.4 and 225 mg/kg at the ÜN and TB stations respectively.

Heavy metal contaminations in the present study were compared with the literature (Table 4). Copper (13.4–50.6), Cr (0.34–1.10) and Zn (33.5–89.5) concentrations in mushroom species from Kayseri, Turkey were found lower than ours; however others were similar (Soylak, Saraçoğlu, Tüzen, & Mendil, 2005). Metal levels in mushroom species from Tokat, were similar with ours with the exception of higher Cd (1.08–7.5) and Pb (1.43–4.17) levels, alongside, smaller Cr (0.87–2.66), Fe (146–835), and Ni (1.18–5.14) levels (Tüzen, 2003). Moreover, levels in fourteen wild mushroom species from the Black Sea region were similar for Pb and Zn, greater for Mn (28.6–145), and smaller for Cu (15.5–63.5) and Fe (150–1741) than what was revealed in this study (Sesli, Tüzen & Soylak, 2008). Concentrations obtained from Türkmenbaba Mountain in, Eskişehir, Turkey were similar with those in our study in terms of Cd, Zn, and Cu, smaller for Mn (6.20–480), and higher for the remaining metals (Yamaç et al. 2007). Iron (187–985) and Cu (18.9–64.8) contaminations in sixteen wild mushroom species from the Eastern Black Sea region were smaller than those found in our study; on the other hand, Mn (53.5–123) concentrations were greater than those found in ours, whilst Cd and Zn concentrations were comparatively similar with the results of this study (Tüzen, Sesli & Soylak, 2007). Cadmium levels in mushrooms from Dambovita County, Romania were similar with our findings; whereas Cr (0.93–13.4), Fe (223–6650) and Pb (0.64–12.5) were greater, and the remaining metals were lower than results of this study (Radulescu et al. 2010). Manganese level in mushrooms from Yunnan Province, China was appearing to be similar to our findings, whilst Pb (0.67–4.43) and Cr (10.7–42.7) were greater than our findings (Zhu et al. 2011).

The present study also estimated the maximum provisional tolerable weekly intake limit for examined edible mushroom species (Table 5). These values were estimated according to the highest level for per heavy metal. As can be seen in Table 5, the maximum intakes levels were greater than 1 kg/week for 70 kg person in terms of Cu, Zn and Cr concentrations, but lower than 1 kg for others.

4. Conclusion

The present results provide important information on heavy metal contamination of the examined species from the region, and thus indicate environmental contamination. In addition, the results of this can also be used to understand the chemical properties of mushrooms, as well as can be used to evaluate any possible risks to human health. Six edible wild mushroom species were obtained from twenty-one stations in the Black Sea region of Turkey. Heavy metal contaminations were analyzed in a total of 108 specimens using an ICP-MS, in mg/kg dry weight. Differences between stations were assessed using One-way ANOVA and Duncan's multiple ranges. The maximum weekly intake limits for each of the examined species were also estimated for per person. According to these results, it is recommended the people who with a body weight of around 70-kg should not consume more than 1 kg of mushrooms per week in terms of Fe, Ni, Mn and Pb.