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Research Article

Mineral Contents of Some Wild Edible Mushrooms

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Abstract: Mineral (Ni, Cu, Co, Zn, Cr, Mn, Mg, Cd, Fe, Ca and Pb) contents of 11 wild edible agaricoid mushrooms (*Coprinus comatus* (Müll.:Fr.) S.F. Gray, *Leucoagaricus leucothites* (Vitt.) Wasser, *Lycoperdon molle* Pers.: Pers., *Pleurotus ostreatus* (Jacq.: Fr.) Kummer, *Volvopluteus gloiocephalus* (DC.) Justo, *Coprinellus micaceus* (Bull.) Vilgalys, Hopple & Jacq. Johnson, *Psathyrella candolleana* (Fr.:Fr.) Mre., *Cyclocybe cylindracea* (DC.) Vizzini & Angelini, *Lepista nuda* (Bull. Fr.) Cke., *Melanoleuca cognata* (Fr.) Konr. & Maubl. ss. Lge. and *Tricholoma terreum* (Schaeff.) P. Kumm.) were determined by an atomic absorption spectrophotometer (AAS). Ca and Fe were found to be the most abundant elements among the mushroom studied. Cr was detected only in 5 mushrooms while Pb was not detected in any of the samples.

Key words: Edible mushrooms, mineral content, atomic absorption spectrophotometer

Bazı Yenilebilir Yabani Mantarların Mineral İçerikleri

Özet: Yenilebilir 11 yabani agarikoit mantar türünün (*Coprinus comatus* (Müll.:Fr.) S.F. Gray, *Leucoagaricus leucothites* (Vitt.) Wasser, *Lycoperdon molle* Pers.:Pers., *Pleurotus ostreatus* (Jacq.:Fr.) Kummer, *Volvopluteus gloiocephalus* (DC.) Justo, *Coprinellus micaceus* (Bull.) Vilgalys, Hopple & Jacq. Johnson, *Psathyrella candolleana* (Fr.:Fr.) Mre., *Cyclocybe cylindracea* (DC.) Vizzini & Angelini, *Lepista nuda* (Bull. Fr.) Cke., *Melanoleuca cognata* (Fr.) Konr. & Maubl. ss. Lge. ve *Tricholoma terreum* (Schaeff.) P. Kumm.) mineral (Ni, Cu, Co, Zn, Cr, Mn, Mg, Cd, Fe, Ca ve Pb) içerikleri atomik absorpsiyon spektrofotometresi kullanılarak belirlenmiştir. Çalışılan mantar örneklerinde en çok gözlenen ağır metaller Ca ve Fe olmuştur. Krom sadece 5 mantar örneğinde gözlenirken, hiçbir örnekte kurşun belirlenememiştir.

Anahtar kelimeler: Yenen mantarlar, mineral içerik, atomik absorpsiyon spectrofotometresi

Introduction

Mushrooms are an important group of organisms in nature and can be found almost everywhere in terrestrial ecosystems, and collection and consumption of them has a long tradition in many countries. Though the knowledge of the nutritional value of wild growing mushrooms has been limited compared to other vegetables, they are usually considered as valuable nutrient sources and many of them are recommended against health problems such as headache, colds, asthma, diabetes etc.(Kalac et al., 1991).

Mineral accumulation in macrofungi has been found to be affected by environmental and fungal factors (Garcia et al., 1998). Amount of organic matter, pH and metal concentrations of underlying soil can be listed as environmental factors. Because of such ecological factors, the fruiting bodies of mushrooms could be relatively rich in mineral contents (Vetter, 1990).

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Although some metals are essential and play important roles in living systems, they may have toxic effects if consumed above threshold concentration levels (Olumuyiwa et al., 2007; Tüzen et al., 2007).

The study aims to determine the mineral content of some agaricoid wild edible mushrooms growing naturally in Gaziantep province (Turkey).

Materials and Methods

The macrofungi specimens were collected from different localities within Gaziantep province (Turkey) within the scope of the TÜBİTAK project TOVAG-212T112. After taking the color photographs and recording the necessary taxonomically important data of the samples, they were transferred to the fungarium and identified with the help of the relevant literature (Breitenbach & Kränzlin, 1991, 1995; Candusso and Lanzoni, 1990; Buczacki, 1992; Jordan, 1995; Pegler et al., 1995; Bessette and Bessette, 1997). The names and habitats of the studied samples were given in Table 1.

Table 1. The names and the habitats of the mushrooms studied

	Studied Mushroom Name	**Habitat**
1	*Coprinus comatus* (O.F. Müll.) Pers.	Meadow
2	*Leucoagaricus leucothites* (Vittad.) Wasser	Meadow
3	*Lycoperdon molle* Pers.	Forest clearings
4	*Pleurotus ostreatus* (Jacq.) P. Kumm.	On *Salix/Populus* sp. trunks
5	*Volvopluteus gloiocephalus* (DC.) Justo	Among grasses
6	*Coprinellus micaceus* (Bull.) Vilgalys, Hopple & Jacq. Johnson	Around *Populus* sp. remains
7	*Psathyrella candolleana* (Fr.) Maire	Around *Populus* sp. remains
8	*Cyclocybe cylindracea* (DC.) Vizzini & Angelini	On *Salix/Populus* sp. trunks
9	*Lepista nuda* (Bull.) Cooke	Forest and shruby areas
10	*Melanoleuca cognata* (Fr.) Konrad & Maubl.	Mixed forest
11	*Tricholoma terreum* (Schaeff.) P. Kumm.	Pine forest

Dried samples of the mushrooms were prepared for analysis according to the procedure followed by Kaçar (1984) and Khairiah et al. (2004). Mushroom samples were washed with ultrapure water and dried at 80 °C for 8-10 hours. Then the samples were crushed and redried at the same temperature and duration. One g of powdered samples were put in 50 ml beakers and 15 ml of HNO_3 were added. After waiting 8-10 hours, 4 ml $HClO_4$ were added and heated gently for about 5-6 hours and cooled. Then 5 ml of H_2O_2 was added and heated till the solution is colorless enough. The solution was cooled and distilled water was added on it until the total volume reaches to 10 ml.

A flame atomic absorbtion spectrophotometer (FAAS) was used for the determination of elements. Metal ion concentrations were determined as six replicates. The absorption measurements of the elements were performed under the conditions recommended by the manufacturer.

Results

Element concentrations of the mushroom samples are presented in Table 2. The metal concentrations were determined on dry weight basis. The results indicate that Calcium and Iron were found to be the most abundant elements among the studied mushroom samples. Ni, Cu, Co, Zn, Mn, Mg, Cd, Fe and Ca were determined in all samples.

Cr was detected only in 5 mushrooms while Pb was not detected in any of them. The average mineral contents in mushroom samples ranged as 0.763-152, 15.57-60.43, 1.305-10.97, 58.69-110.9, 0.425-15.59, 7.115-138.2, 61.03-67.23, 1.345-5.908, 59.42-585.3, 309.2-2627 mg/kg dw for Ni, Cu, Co, Zn, Cr, Mn, Mg, Cd, Fe and Ca respectively.

Table 2. Mineral contents of studied wild edible mushrooms

No	Amount of minerals (mg/kg dry weight)										
	Ni	Cu	Co	Zn	Cr	Mn	Mg	Cd	Fe	Ca	Pb
1	10,89	50,43	3,405	58,69	4,095	31,08	62,39	2,57	306,4	2627	nd
2	3,305	32,51	1,305	82,38	nd	9,95	61,03	1,625	59,42	590,5	nd
3	152	24,82	10,97	81,12	8,203	68,53	67,23	2,765	585,3	584,2	nd
4	2,445	15,57	1,57	110,9	0,425	10,43	61,8	1,97	106	309,3	nd
5	59,21	27,94	7,31	65,62	15,59	138,2	65,22	1,345	585	2404	nd
6	5,14	18,42	2,513	73,23	nd	12,91	62,34	2,613	148,4	1794	nd
7	8,018	60,43	3,448	97,5	1,58	45,57	63,54	1,758	382,8	2397	nd
8	2,368	27,6	1,733	66,63	nd	7,115	62,87	2,455	61,43	1037	nd
9	3,725	34,31	2.428±	72,72	nd	19,88	62,29	2,723	156	1361	nd
10	3,218	25,9	2,25	67,83	nd	53,19	61,91	2,265	84,47	562,9	nd
11	0,763	21,49	2,42	81,82	2,543	12,54	62,07	5,908	217,4	2487	nd

Discussion

Except chromium and lead, all the minerals were determined in all the mushrooms studied. Chromium was detected in *Coprinus comatus, Lycoperdon molle, Pleurotus ostreatus, Volvopluteus gloiocephalus, Psathyrella candolleana* and *Tricholoma terreum* while lead was not detected in any of the mushrooms studied.

Nickel content ranged from 0.763 (*Tricholoma terreum*) to 152.0 (*Lycoperdon molle*) mg/kg dw. Ni content was determined as 44.6–127, 0.4–15.9, 2.73–19.4, 0.4–2, 8.2–26.7, 1.72–24.1, 44.6–127 mg/kg dw by Demirbaş (2001), Işıldak et al. (2004), Işıloğlu et al. (2001), Kalač and Svoboda (2001), Mendil et al. (2004) and Soylak et al. (2005) respectively. Except *L. molle*, Ni content of the mushrooms are in agreement with previous studies. Nickel has been linked to lung cancer and the tolerable upper intake level for this toxic element is reported as 1 mg/day (Anonymous, 1993).

The Cupper content was 15,57 mg/kg dw in *Pleurotus ostreatus* and 60.43 mg/kg dw for *Psathyrella candolleana*. The determined magnesium levels are in the range of reported amounts. Tüzen et al. (1998) and Sesli and Tüzen (1999) reported copper contents of wild edible mushrooms as being between 4.71-51 and 10.3-145 mg/kg dw. Cupper concentrations are generally reported within the range of 100-300 mg/kg dw and such amounts don't cause a health risk (Kalač and Svoboda, 2001).

Minimum and maximum values of cobalt were 1.305 and 10.97 mg/kg dw. The highest and lowest levels were found in *Lycoperdon molle* and *Leucoagaricus leucothites*, respectively. The amount of cobalt was determined as 7.42 mg/kg dw for *Agrocybe dura* (Kaya and Bağ, 2010), 7.2 mg/kg dw for *Ramaria largentii* (Ouzuni et al., 2009) and 5.8 mg/kg dw for *Agaricus arvensis (*Borovička & Řanda, 2007). Except *Lycoperdon molle*, the determined cobalt contents are in agreement with the previous studies.

Generally, the zinc values in the present study are in agreement with reported literature values.

It was ranged from 58.69 mg/kg dw (*Coprinus comatus*) to 110.9 mg/kg dw (*Pleurotus ostreatus*). In a review, tracing the studies on mineral contents of mushrooms, Kalač and Svoboda (2001) reported the zinc content as ranging from 30 to 150 mg/kg dw. So far the highest zinc content was measured as 173.8 mg/kg dw in *Tricholoma equestre* (Işıldak et al., 2004).

Chromium was determined in six mushroom samples and the content was ranged from 0.425 mg/kg (*Pleurotus ostreatus*) to 15.59 mg/kg dw (*Voluopluteus gloicephalus*). It was not determined in *Cyclocybe cylindracea, Coprinellus micaceus, Leucoagaricus leucothites, Melanolouca cognata* and *Lepista nuda*. Tüzen (2003) reported Cr content as 0.87-2.66 mg/kg dw, Sivrikaya et al. (2002) as 7.0-11.0 mg/kg and Kaya et al. (2011) as 0.77-80.03 mg/kg dw. Because of its ability to increase glucose tolerance in type-2 diabetes mellitus patients (Anderson, 2000), chromium is considered essential to man. The recommended dietary intake for chromium is 0.035 mg/day for male and 0.025 mg/day for the female (Anonymous, 2001). Mushrooms could be thought as a potential source of this element.

Unlike chromium, manganese was determined in all mushrooms studied and ranged from 7.12 in *Cyclocybe cylindracea* to 138.2 mg/kg dw in *Voluopluteus gloicephalus*. Manganese values in the literature have been reported in the ranges: 5.0–60.0 mg/kg dw (Kalač and Svoboda, 2001) and 5.54-135 mg/kg dw (Gençcelep et al., 2009), respectively. Though *V. gloiocephalus* seems to contain considerably high Cr, the determined Cr content are generally in agreement with those presented before.

As it is the case for some other minerals investigated in this study, *Lycoperdon molle* contained the highest magnesium content with an amount of 67.23 mg/kg dry matter. Magnesium levels ranged between 61.8 mg/kg dw and 65.22 mg/kg dw for the other mushroom species, studied. Uzun et al. (2011) reported the magnesium values as 180 mg/kg dw and 1930 mg/kg dw for *Pleurotus fuscus* var. *ferulae* and *Lycoperdon pyriforme* respectively. Likewise Demirbaş (2001) reported the content of this mineral as 330 mg/kg dw in *Tricholoma anatolicum* and 6560 mg/kg dw in *Morchella deliciosa*. Türkekul et al. (2004), Sesli et al. (2008) and Tüzen et al. (2007) also reported the magnesium content within the range of 688 mg/kg dw and 1150 mg/kg dw. Compared to earlier published reports the determined levels of magnesium is relatively low.

Since it inhibits many life processes, cadmium is known as a principal toxic element (Kalač and Svoboda, 2004) and has been associated with renal damage; cancer and childhood aggression (Anonymous, 1993). Acceptable daily intake of this mineral is reported by World Health Organization (Anonymous, 1993) as 0.06-0.07 mg/day/kg body weight. In our study, cadmium contents ranged from 1.345 mg/kg dw for *Volvopluteus gloiocephalus* to 5.908 mg/kg dw for *Tricholoma terreum*. In some previous studies the content of cadmium in wild mushrooms were reported as 0.81–7.50 mg/kg (Svoboda et al., 2000), 0.10–0.71 mg/kg (Mendil et al., 2004), 0.28–1.6 mg/kg (Mendil et al., 2005) and 0.12– 2.60 mg/kg (Malinowska et al., 2004). Determined cadmium contents of this study are in agreement with the literatural data.

Adequate iron level in a diet was reported to be very important in order to decrease the incidence of anemia (Uzun et al., 2011). Iron content was determined to be at the lowest level (59.42 mg/kg dw) in *Leucoagaricus leucothites* and at the highest level (585.3 mg/kg dw) in *Lycoperdon molle*. Our iron measurements are in agreement with the findings of previous studies. The reported iron contents ranged between 5.0 and 7162 mg/kg dw (Sesli and Tüzen, 1999; Işıloğlu et al., 2001; Gençcelep et al., 2009, Kaya et al., 2011; Uzun et al., 2011).

All the mushroom samples contained calcium and ranged from 309.3 mg/kg dw (*Pleurotus ostreatus*) to 2627 mg/kg dw (*Coprinus comatus*).

For other mushroom samples the measured calcium contents were between 309.3-2487 mg/kg dw. Compared to reports of Kalač, (2009) (100-2400 mg/kg dw) and Sanmeea et al. (2003) (100-2400 mg/kg dw), determined calcium contents for some samples seems to be higher. But Uzun et al. (2011) measured the calcium content of *Laetiporus sulphureus* as 5700 mg/kg dw. Likewise Gençcelep et al. (2009) reported the calcium content to be 8800 mg/kg for *Lepista nuda*.

Lead was not determined in any of the mushroom samples studied. Kalač & Svoboda, (2001) reported the lead contents of wild growing mushrooms as being between 0.5-20 mg/kg dw. Kaya and Bağ (2010) measured lead contents between 1.445 mg/kg dw and 3.371 mg/kg dw. But Uzun et al (2011), Kaya et al. (2011), Kaya and Bağ (2013) could not determine this mineral in many of the mushrooms they studied. The acceptable daily intake of Pb for adults is 0.21-0.25 mg/day (Anonymous 1993).It means that consumption of wild edible mushrooms collected from these habitats within Gaziantep province may not have any harmful effect if not overconsumed.

Analysis of the determined mineral contents and the comparison of them with previously reported values indicate that the wild growing edible mushrooms, collected from Gaziantep province and evaluated in this study, generally contained considerable amounts of minerals but lower toxic metal contents (Pb, Cd, Cr), and can be used as a natural food source without any health risk.

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