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Trace Metal Contents of Higher Fungi from Zigana Highland in Turkey

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Higher fungus specimens were collected from Zigana Highland at East Black Sea Region of Turkey. The specimens were observed under microscope, photographed and deposited in a personal fungarium at the Black Sea Technical University in Trabzon, Turkey. As a result of field and laboratory studies, 14 higher fungus taxa (*Lepiota clypeolaria, Leucoagaricus leucothites, Agaricus arvensis, Coprinus atramentarius, Amanita pantherina, Amanita franchetii, Panaeolus acuminatus, Entoloma sinuatum, Entoloma chalybaeum, Clitopilus prunulus, Tricholomopsis rutilans, Tricholoma virgatum, Tricholoma terreum, Tricholoma imbricatum*) were recorded. Trace metal contents of specimens were determined by atomic absorption spectrometry after microwave digestion. The results were (in mg/kg) 25–153 iron, 9.3–40.4 copper, 10.6–36 manganese, 30.7–168 zinc, 13.2–330 aluminium and 0.2–9.2 lead.

Key Words: Trace metal, Higher fungus, Atomic absorption spectrometry, Turkey.

INTRODUCTION

The fruiting bodies of higher fungi (mushroom) are present almost everywhere in nature and their consumption continues to increase in many countries[1]. Their fruiting bodies can contain great concentrations of trace metals such as iron, copper, manganese, zinc, aluminium and lead[2–11].

Turkey has a rich mycota and is the largest producer of wild higher fungi in the Middle East[12]. Picking and consumption of wild higher fungi has been a very popular delicacy especially in Black Sea Region of Turkey and yearly consumption may exceed 6 kg for some people as well as a higher content of trace metals. Several studies have been carried out on the trace metal contents in fruiting bodies of the wild growing higher fungi in Turkey[13–27]. In a previous study[28] the authors were interested in micro and macro element contents of edible wild growing higher fungi in Artvin, Turkey. The present study was initiated to evaluate trace metal contents in fruiting bodies of wild growing edible, inedible and poisonous mushroms in Zigana Highland of Turkey. Zigana Highland is situated far away from the sources of industrial pollution, also a ski centre. From the centre, Trabzon

is 112 km in the southeast in East Black Sea Region of Turkey. From sea level it is 2032 m high and a very interesting place in Turkey which is caught between the sea climate on one side and the continental on the other.

The aim of this study was to determine the contents of six important metals, iron, copper, manganese, zinc, aluminium and lead in fruiting bodies of edible, inedible and poisonous higher fungi growing in Zigana Highland of Turkey.

EXPERIMENTAL

The specimens were collected from Zigana Highland at East Black Sea Region of Turkey between May 2004–July 2005. Ecological properties of species were noted in the research area and the microscopic investigations of specimens were made according to Sesli *et al.*[29] The taxa were identified according to Breitenbach and Kränzlin[30]. Some specimens were deposited in the personal fungarium at the Faculty of Fatih Education at Karadeniz Technical University in Trabzon, Turkey.

For chemical analysis, the specimens were dried at 105°C for 24 h. Dried specimens were homogenized using an agate homogenizer and stored in polyethylene bottles until analysis. All the plastic and glassware were cleaned by soaking with the contact overnight in a 10% nitric acid solution and then rinsed with deionized water. 1 g of sample was digested with 6 mL of concentrated HNO_3 and 2 mL of concentrated H_2O_2 in Milestone Ethos D model microwave digestion system and diluted to 10 mL with double deionized water. A blank digest was carried out in the same way. The accuracy of the method was verified by standard reference materials. A Perkin-Elmer Analyst 700 model atomic absorption spectrometer with deuterium background corrector was used in this study. Aluminum and lead levels in the higher fungus specimens were determined by HGA graphite furnace using argon as inert gas. The other elements were determined in air-acetylene flame.

RESULTS AND DISCUSSION

At the end of field and laboratory studies, 14 higher fungi taxa were identified. The systematics were given according to Sesli and Denchev[12] (Basidiomycota, Basidiomycetes, Agaricomycetidae, Agaricales). The fungal names, families and some properties of species are as follows: *Lepiota clypeolaria* (Bull.) Quel. (Agaricaceae), under *Picea orientalis*, poisonous; *Leucoagaricus leucothites* (Vittad.) M.M. Moser ex Son (Agaricaceae), in grass along road verges, poisonous; *Agaricus arvensis* Schaeff. (Agaricaceae), amongst grass in pasture, edible-excellent; *Coprinus atramentarius* (Bull.) Fr. (Coprinaceae), in woodland, poisonous; *Amanita pantherina* (DC.) Krombh. (Pluteaceae), mycorrhizal with *Carpinus orientalis*, deadly poisonous; *Amanita franchetii* (Boud.) Fayod (Pluteaceae), under *Picea orientalis*, edible; *Panaeolus acuminatus* (Schaeff.) Quel. (Bolbitiaceae), in meadows, not edible; *Entoloma sinuatum* (Bull.) P. Kumm. (Entolomataceae), in deciduous woodland, poisonous; *Entoloma chalybaeum* (Fr.) Noordel. (Entolomataceae), in pasture, poisonous; *Clitopilus prunulus* (Scop.) Fr. (Entolomataceae), in grass in open woodland edible-good; *Tricholomopsis rutilans* (Schaeff.) Singer (Tricholomataceae), on *Picea orientalis*, edible; *Tricholoma virgatum* (Fr.) P. Kumm. (Tricholomataceae), under *Carpinus orientalis*, not edible; *Tricholoma terreum* (Schaeff.) Quel. (Tricholomataceae), under *Picea orientalis*,

edible; *Tricholoma imbricatum* (Fr.) P. Kumm (Tricholomataceae), under *Picea orientalis*, edible.

Six species analyzed in this paper are edible (*Agaricus arvensis, Amanita franchetii, Clitopilus prunulus, Tricholomopsis rutilans, Tricholoma terreum, Tricholoma, imbricatum*), two are inedible (*Panaeolus acuminatus, Tricholoma virgatum*) and rest of them are poisonous (*Lepiota clypeolaria, Leucoagaricus leucothites, Coprinus atramentarius, Amanita pantherina, Entoloma sinuatum* and *Entoloma chalybaeum*). Edible species in our study are popular food and are collected for domestic use by local people.

All metal concentrations were determined on a dry weight basis. Table-1 presents the results of the analysis of trace metal contents (in mg/kg) in the specimens.

TABLE-1
TRACE METAL CONTENTS OF SPECIMENS (mg/kg)

Species	Fe	Cu	Mn	Zn	Al	Pb
Lepiota clypeolaria	142 ± 28.3	24.6 ± 5.7	28 ± 7.5	143 ± 29.2	118 ± 21.2	0.3 ± 0.02
Leucoagaricus leucothites	153 ± 30. 5	38.3 ± 12.9	11.7 ± 2.5	85 ± 20.4	22.5 ± 4.7	2.3 ± 1.2
Agaricus arvensis	143 ± 28.5	12.7 ± 3.2	26.3 ± 6.4	168 ± 30.4	13.2 ± 2.2	0.2 ± 0.02
Coprinus atramentarius	85 ± 23.5	18.7 ± 4.2	22 ± 5.2	68 ± 17.9	28.5 ± 5.6	0.8 ± 0.4
Amanita pantherina	95 ± 26.2	36.4 ± 10.4	19.5 ± 4.2	30.7 ± 8.3	116 ± 21.3	7.8 ± 1.2
Amanita franchetii	25 ± 6.2	40.4 ± 13.4	18.2 ± 4.1	114 ± 20.4	42.9 ± 5.7	4.3 ± 1.4
Panaeolus acuminatus	60 ± 15	14.7 ± 3.8	35 ± 9.4	89.8 ± 22.1	32 ± 5.4	0.6 ± 0.4
Entoloma sinuatum	40 ± 13.1	30.2 ± 8.2	15.2 ± 3.1	72.8 ± 16.5	120 ± 21.7	8.3 ± 2.1
Entoloma chalybaeum	39 ± 12.2	32.8 ± 9.3	36 ± 9.7	159 ± 32.2	24.9 ± 5.2	2.7 ± 1.2
Clitopilus prunulus	125 ± 23.2	9.3 ± 2.4	33 ± 4.5	72.4 ± 10.3	13.3 ± 2.2	0.4 ± 0.2
Tricholomopsis rutilans	86.2 ± 20.4	13.5 ± 3.4	10.7 ± 2.3	60.8 ± 8.5	113 ± 19.4	5.3 ± 2.1
Tricholoma virgatum	67.4 ± 16.2	12.3 ± 3.8	16.3 ± 4.1	90.3 ± 19.7	31.8 ± 7.1	3.7 ± 1.3
Tricholoma terreum	85.0 ± 20.9	24.2 ± 5.1	10.6 ± 2.3	155 ± 31.2	140 ± 23.6	9.2 ± 2.2
Tricholoma imbricatum	68.9 ± 17.8	10.6 ± 2.4	17.5 ± 4.5	165 ± 39	330 ± 62.5	3.7 ± 1.1

The results of trace metal concentrations were (in mg/kg) 25–153 iron, 9.3–40.4 copper, 10.6–36 manganese, 30.7–168 zinc, 13.2–330 aluminium and 0.2–9.2 lead. The lower and higher iron content was found 25 mg/kg in *Amanita franchetii* and 153 mg/kg in *Leucoagaricus leucothites*, respectively. The average iron content for the specimens was 86.8 mg/kg. Iron values in higher fungus specimens have been reported in the range of 31.3–1190 μg/g[14], 568–3904 μg/g[22], 56.1–7162 μg/g[16], 102–1580 μg/g[27], respectively. The iron levels in the present study were found to be lower than those reported in the literature, because our collecting site was far away from industrial foundations.

The copper levels had ranges of 9.3–40.4 mg/kg for *Clitopilus prunulus* and *Amanita franchetii* respectively. The average copper contents for specimens were 22.8 mg/kg. Copper contents of higher fungus specimens in the literature have been reported in the range of 4.71–51.0 μg/g[13], 12–181 μg/g[21], 10.3–145 μg/g[24], 34.5–83.0 μg/g[16], 10.0–14.0 μg/g[19], 13.4–50.6 μg/g[27], respectively. Copper contents found in this study are in agreement with those reported in literature.

The manganese content of the specimens studied ranged from 10.6 mg/kg in *Tricholoma terreum* to 36 mg/kg in *Entoloma chalybaeum.* The average manganese content of the specimens was 21.4 mg/kg. The reported manganese values in literature for higher fungi were 14.2–69.7 μg/g[27], 21.7–74.3 μg/g[20], 7.1–81.3 μg/g[23], respectively. The manganese levels in the present study were found to be lower than those reported in literature, because the collecting site was far away from industrial foundations.

The zinc content was the least (30.7 mg/kg) in *Amanita pantherina,* whereas in *Agaricus arvensis* it was the highest (168 mg/kg). The average zinc content of specimen was 105.3 mg/kg. Zinc concentrations of higher fungus specimens in literature have been reported in the range of 33.5–89.5 μg/g[27], 29.3–158 μg/g [16], 45–188 μg/g[20]. The zinc values in the present work are in agreement with those reported in literature. Zinc is known to be involved in most metabolic pathways in humans and zinc deficiency can lead to loss of appetite, growth retardation, skin changes and immunological abnormalities.

Aluminium content ranged from 13.2 mg/kg in *Agaricus arvensis* to 330 mg/kg in *Tricholoma imbricatum.* The average aluminium content of specimens was 81.9 mg/kg. Aluminium contents of higher fungus specimens have been reported in the range of 95–175 mg/kg[19], 8.5–365 mg/kg[1] and 7.9–943 mg/kg[9]. Aluminium is not considered to be an essential element in humans. Exposure of aluminium has been implicated in a number of human pathologies including encephalopathy/dialysis dementia, Parkinson disease and Alzheimer's disease[24].

The lead content ranged from a high of 9.2 mg/kg in *Tricholoma terreum* to a low of 0.2 mg/kg in *Agaricus arvensis.* The average lead content of specimens was 3.5 mg/kg. Lead contents of higher fungi specimens in literature have been reported in the range of 0.40–2.80 μg/g[10], 0.75–7.77 μg/g[21], 1.43–4.17 μg/g[20] and 0.75–1.99 μg/g[27]. The lead values in the present work are in agreement with those reported in the literature.

The order of the levels of trace metal in the species was found to be as Zn > Fe > Al > Cu > Mn > Pb.

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