HEAVY METAL LEVELS IN WILD EDIBLE MUSHROOM SAMPLES FROM NAYAGRAM BLOCK OF MIDNAPORE DISTRICT, WEST BENGAL

NILANJANA DAS

Rural Development Centre,
Indian Institute of Technology,
Kharagpur (West Bengal).

Introduction

Wild mushrooms are one of the most important Non-Wood Forest Products (NWFPs) in India. The use of wild mushrooms as food began with prehistoric man. Early man by trial and error became familiar with the types of mushrooms worth collecting for eating purpose (Atri *et al*., 1997). More than 2000 species of mushrooms are reported to be edible throughout the world and about 283 of these are reported to be available in India (Purkayastha and Chandra, 1985).

Mushrooms are known to accumulate high levels of heavy metals. The concentrations of heavy metals in mushrooms are considerably higher than those in agricultural crop plants, vegetable and fruits. This suggests that mushrooms possess a very effective mechanism that enables them readily to take up heavy metals from the ecosystem. The concentrations of heavy metals in the fruiting bodies of mushrooms are primarily species dependent. The concentrations were found to depend on physiology of the species and particularly on its ecosystem pattern (Lepsova and Mejestrik, 1998).

International studies have drawn attention to the occurrence of the heavy metal contents of mushrooms in unpolluted and mildly polluted areas (Demirbas, 2000a;2000b; 2001; 2002; Falandaysz *et al*., 1992; Gast *et al*., 1988; Isildok *et al*., 2004; Kalac *et al*., 2004; Lepsova and Mejestrik, 1998; Sesli and Tuzen, 1999; Tuzen *et al*., 1999; Vetter, 1993, 1994). Contaminated mushrooms occur mainly along the roads with extensive traffic (Cuny *et al*., 2001; Kuthan, 1979) or in the emission areas of metal smelters (Kalac and Svoboda, 2000) etc.

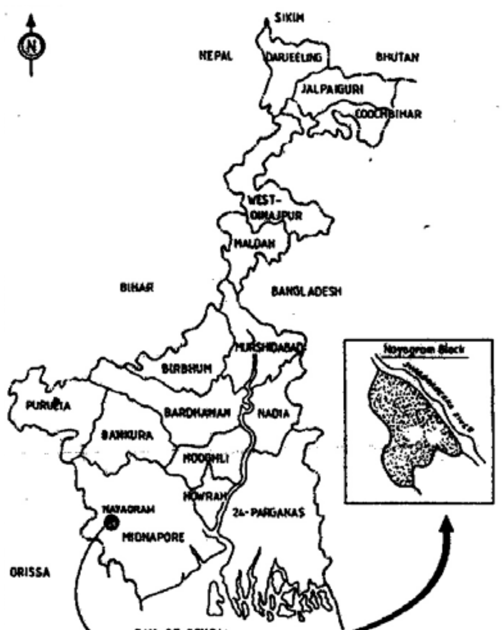
In West Bengal, there is a well established consumer acceptance of cultivated mushrooms like *Pleurotus sajor caju, Pleurotua florida, Pleurotus flabellatus, Calocybe indica, Volvariella volvacea, Volvariella diplasia* etc. However, wild mushrooms are also being consumed traditionally by a group of people seasonally and becoming increasingly important in their diet. People from forest fringe areas collect wild edible mushrooms from forests or other sources. The toxic effects of heavy metals in the wild varieties may not be realized immediately but long term effects will definitely be hazardous to mushroom consumers.

Keeping the above in view, the present study was carried out to find out the levels of heavy metals in the fruiting bodies of 10 wild edible mushrooms collected from the study region.

Material and Methods

Study area : The study was conducted in the Nayagram Block, located in the South-western part of Midnapore District, West Bengal. The river Subarnarekha has shaped its North boundary. The western, southern and South-western parts are bounded by the District of Mayurbhanj of Orissa and Eastern and South-eastern parts are covered by the District of Balasore of Orissa (Fig. 1). The block covers a geographical area of 503.15 km^2 and has a sum total of 18,418.8 ha of forest lands. In this region, the climate is mild and rainy. The total annual rainfall ranges from 1,200-1,400 mm. The climate during the year, especially the rainy season is ideal for mushroom growth.

Fig. 1



Collection site of mushroom specimens

A total of 112 samples were analyzed, representing 10 different wild edible mushroom species. The study area was classified in two categories viz. roadside area and forest area. Roadside areas are exposed to pollutants from automobile traffic for many years. Samples collected were *Agaricus arvensis, Agaricus campestris, Auricularia polytricha, Astraeus hygrometricus, Cantharellus cibarius, Coprinus comatus, Coprinus micaceus, Lycoperdon pyriforme, Macrolepiota procera, Leucocoprinus cepaestipes.*

To identify the samples, the habitat and morphological characteristics of the mushrooms were recorded and photographed. The mushrooms were then brought to the laboratory and their spore prints were made and size of basidiospores/gills measured. Microscopic examinations were performed using Nikon research microscope. Specimens were identified by reference books (Moser, 1983; Purkayastha and Chandra, 1985).

Collected mushrooms were cleaned, cut into slices and the samples were washed with demineralised water. Each sample was dried at 50°C overnight and crushed in a mortar and pestle. Digestion of mushroom samples was performed using an oxi-acidic mixture of HNO_3 : H_2SO_4 : H_2O_2 (4 : 1 : 1, 12 ml for 2-4 g sample) and heating at 75°C for 3 h. After cooling, 20 ml demineralized water was added, the digest was again heated up to 150°C for 4 h and brought to a volume of 25 ml with demineralized water (Demirbas, 2000b; Tuzen *et al.*, 1999). Lead and cadmium levels in the mushroom samples were determined using a GBC 3000 graphite furnace for AAS. Determination of other metals (Cu, Zn, Mn, Fe and Ni) contents were carried out with a GBC 932 model AAS using flame atomization. The standard-addition procedure was used in all determinations.

The wave length and silt values, as nm, used for the determination of Pb, Cd, Cu, Zn, Mn, Fe and Ni were : 283.3 and 0.5, 228.8 and 0.5, 324.7 and 0.5, 213.9 and 0.5, 279.5 and 0.2, 248.3 and 0.2, 232.0 and 0.2 respectively.

Results and Discussion

Ten species of wild edible mushrooms were collected both from roadside and forest area of Nayagram Block of Midnapore District of West Bengal. The total number of samples from roadside were 55 and from the forest area 57. The habitat and the families of mushrooms used in this study are given in Table 1. Heavy metal concentrations in the mushrooms species were analyzed and the results are given in Table 2. In this table, the number of samples (n), mean concentrations and standard deviations (M SD) are indicated for both the groups.

Lead concentration ranged from 1.0 to 4.7 mg/kg for samples from the roadside and from 1.0 to 2.9 mg/kg for samples from the forest area. The highest mean level was found to be 4.7 mg/kg in *Coprinus micaceus* from the roadside. In relation to the pollution source near main roads, Jorhem and Sundstrom (1995) concluded that lead derives mainly from the contaminated roadside soil rather than from atmospheric deposition.

Cadmium content of mushroom ranged from 0.24 to 0.84 mg/kg for samples from roadside and from 0.16 to 0.80 mg/kg for forest area samples. The highest mean

Table 1

Families and habital of wild edible mushrooms collected from the roadside and forest areas of Nayagram block, Midnapore District of West Bengal.

Sl. No.	Mushroom species	Family	Habitat
1.	*Agaricus arvensis* Schaeffer	Agaricaceae	Meadows, Pastures
2.	*Agaricus campestris* L. ex Fr.	Agaricaceae	Manured ground, fields
3.	*Auricularia polytricha* (Mont.) Sace	Auriculariaceae	Wood, dead logs
4.	*Astraeus hygrometricus* (Pers.) Morgan	Astreaceae	Soil
5.	*Cantharellus cibarius* Fr.	Cantharellaceae	Soil
6.	*Coprinus comatus* (Mull. ex Fr.) S.F.Gray	Coprinaceae	Grassland, lawn, garden, field
7.	*Coprinus micaceus* (Bull. Ex Fr.) Fr.	Coprinaceae	Rotting wood, on stumps
8.	*Lycoperdon pyriforme* (Pers.)	Lycoperdaceae	Sandy soil
9.	*Macrolepiota procera* (Scop: Fr.) Sing	Agaricaceae	Field
10.	*Leucocoprinus cepaestipes* (Sow. ex.Fr.) Patouillard	Amanitaceae	Woody debris

Table 2

Levels of Pb, Cd, Cu, Zn, Mn, Fe and Ni of the mushroom samples analyzed (mg/kg, dry wt.). Data are represented as means (M) and standard deviations (SD).

Mushroom samples	Area	Value	Heavy metals (mg/kg, dry wt.)						
			Pb	Cd	Cu	Zn	Mn	Fe	Ni
1. *Agaricus*	R(5)	M SD	1.8 0.3	0.45 0.05	47 8	66 15	36 5	535 101	2.9 1.4
arvensis	F(5)	M SD	1.4 0.4	0.16 0.02	24 10	54 10	15 2	1039 98	5.5 0.5
2. *Agaricus*	R(6)	M SD	1.0 0.4	0.31 0.10	36 7	95 3	30 4	315 32	2.0 0.6
campestris	F(5)	M SD	1.6 0.5	0.34 0.50	27 16	88 10	28 4	276 120	2.4 0.7
3. *Auricularia*	R(6)	M SD	1.2 0.1	1.40 0.50	31 2	120 3	12 1	698 80	2.5 0.6
polytricha	F(7)	M SD	1.7 0.9	1.90 0.20	36. 3	115 7	18 3	240 20	3.6 1.8
4. *Astraeus*	R(7)	M SD	1.5 0.2	0.24 0.1	26 8	132 11	25 5	890 25	5.5 0.5
hygrometricus	F(7)	M SD	1.9 0.1	0.22 0.1	24 3	116 12	17 2	939 36	2.5 0.6
5. *Cantharellus*	R(5)	M SD	1.5 0.6	0.41 0.2	58 7	96 3	20 9	1438 296	3.4 2.7
cebarius	F(7)	M SD	1.3 0.3	0.46 0.2	57 10	88 10	13 10	850 324	6.6 1.7
6. *Coprinus*	R(5)	M SD	4.4 0.2	0.58 0.17	37 5	27 3	16 5	1039 98	4.4 1.6
comatus	F(5)	M SD	2.0 0.3	0.80 0.30	46 3	25 1	18 6	889 36	4.5 1.3
7. *Coprinus*	R(6)	M SD	4.7 1.1	0.84 0.11	41 3	88 5	37 6	714 12	2.5 0.5
micaceus	F(7)	M SD	2.9 1.1	0.51 0.21	37 4	83 8	32 2	485 24	2.7 0.8
8. *Lycoperdon*	R(4)	M SD	1.7 0.3	0.42 0.30	54 3	82 16	22 6	238 34	4.3 1.6
pyriforme	F(3)	M SD	1.6 0.4	0.34 0.27	59 3	72 10	21 5	464 12	5.9 1.4
9. *Macrolepiota*	R(7)	M SD	1.4 0.5	0.67 0.10	25 3	86 1	29 6	376 144	8.6 2.3
procera	F(7)	M SD	1.4 0.6	0.61 0.16	39 7	86 8	12 8	1214 184	4.2 1.1
10. *Leucocoprinus*	R(4)	M SD	1.8 0.2	0.46 0.20	24 5	95 10	22 5	1422 70	1.8 0.6
cepaestipes	F(4)	M SD	1.0 0.1	0.42 0.39	35 9	135 24	25 3	750 364	1.2 0.3

R : Roadside areas, F : Forest areas

concentration was determined to be 0.84 mg/kg in *Coprinus micaceus* for roadside areas. Traffic pollution was not a significant factor for cadmium accumulation in mushrooms reported by Melgar *et al.* (1998). Very high concentration of cadmium have been found in the genus *Agaricus* (Kojo and Lodenius, 1989; Lodenious *et al.*, 1981; Quinche, 1987; Schmitt and Meisch, 1985; Vetter, 1994). In the present study, highest concentration was 0.45 mg/kg in roadside areas and lowest concentration was 0.16 mg/kg in forest areas in case of *Agaricus arvensis.*

The minimum and maximum

concentration of copper in collected samples ranged from 24 to 58 mg/kg for roadside and from 24 to 59 mg/kg for forest area. The highest mean level in *Cantharellus cibarius* and the lowest mean level in *Leucocoprinus cepaestipes* was recorded from the samples from roadside. Copper contents in mushrooms higher than those in vegetables should be considered as a nutritional source of the element. Nevertheless, for people, bioavailability from mushrooms was reported to be low, due to limited absorption from the small intestine (Schellmann *et al.*, 1980).

In this study, the zinc content in mushroom ranged from 27 to 132 mg/kg for samples from roadside and from 25 to 135 mg/kg for the forest area samples. The highest zinc contents were found in *Astreaus hygrometricus* for roadside as well as in *Leucocoprinus cepaestipes* in the forest area. The lowest mean level was recorded in *Coprinus comatus* for both the areas. Zinc is widespread among living organisms due to its biological significance. Concentration of zinc related to mushrooms ranged from 30 to 150 mg/kg reported by Kalac and Svoboda (2000). Hence, Zinc content in mushrooms of the present study is in agreement with the previous studies of other workers (Anderson *et al.*, 1982; Kalac and Svaboda, 2000).

The value of manganese concentrations in mushroom samples ranged from 12 to 37 mg/kg for roadside and from 12 to 32 mg/kg for the forest areas. In the roadside, relatively high concentrations were found in *Coprinus micaceus* and *Agaricus arvensis* whereas minimum mean values were recorded in *Auricula polytricha.*

The iron content of mushrooms ranged from 238 to 1438 mg/kg for roadside and from 240 to 1214 mg/kg for the forest areas. The highest concentrations of iron was found in *Cantharellus cibarius* (1438 mg/kg), *Leucocoprinus caepastipes* (1422 mg/kg) in the roadside and 1214 mg/kg in *Macrolepiota procera* in forest area. Concentrations of iron in other species were low.

The minimum and maximum values of nickel in ranged 1.8 to 8.6 mg/kg for roadside areas and 1.2 to 6.6 mg/kg for forest areas. Highest mean concentration of nickel was found in *Macrolepiota procera* from roadside. The maximum nickel level from forest area was noted in *Cantharellus cibarius.* Minimum mean values were recorded in *Leucocoprinus cepaestipes* for both the areas.

Conclusion

In this study, the levels of heavy metal concentration of wild edible mushrooms collected from roadside and forest areas of Nayagram Block of Midnapore District, West Bengal were investigated. The amount of heavy metal contents varied according to the collection site of the sample. Levels of heavy metals were comparatively higher in case of mushrooms grown on roadside. According to Kalac *et al.* (1991), the amount of heavy metal contents are related to species of mushroom, collected site of the sample, age of fruiting bodies and mycelium and distance from the source of pollution. The heavy metal concentration in mushroom are hardly affected by pH or organic matter content of the soil (Demirbas, 2002; Gast *et al.*, 1988; Sesli and Tuzen, 1999).

Among the heavy metals assayed, cadmium and lead are considered as detrimental heavy metals. According to FAO/WHO (1976), acceptable weekly intakes of cadmium and lead for adults are 0.5 mg and 3 mg respectively. In the present study, the lead and cadmium levels of some wild edible species viz. *Coprinus comatus, Coprinus micaceus* and *Macrolepiota procera* found to be high on the basis of statutory limits. Therefore, people of this region should be careful regarding the consumption of these metal contaminated mushrooms.

Acknowledgement

This work was performed with the financial support from Department of Science and Technology, Govt. of India under Women Scientists Scheme.

SUMMARY

Concentrations of heavy metals (Pb, Cd, Cu, Zn, Mn, Fe and Ni) were determined in the fruit bodies of ten edible mushrooms collected from two different areas (roadside and forest areas) of Nayagram Block of Midnapore District, West Bengal. The analyses were performed using Atomic Absorbtion Spectrophotometer. In the mushrooms, the highest metal concentrations were measured as 4.7, 0.84, 59.0, 135.0, 37.0, 1438.0 and 8.6 mg/kg (dry weight basis) for Pb, Cd, Cu, Zn, Mn, Fe and Ni in *Coprinus micaceus, Coprinus micaceus, Lycoperdon pyriforme, Leucocoprinus cepaestipes, Canstharellus cibarius* and *Macrolepiota procera* respectively. The results indicated that the levels of some detrimental heavy metals viz. cadmium and lead were high in some wild edible species viz. *Coprinus micaceus, Coprinus comatus* and *Macrolepiota procera*. Therefore, it is wise to restrict the consumption of these mushrooms collected from roadside area of the study region.

जिला मिदनापुर, पश्चिम बंगाल के नयग्राम खण्ड से प्राप्त जंगली खाद्य खुम्बी नमूनों में मिले भारी धातु स्तर

नीलांजना दास

सारांश

जिला मिदनापुर, पश्चिम बंगाल के नयग्राम खण्ड के दो विभिन्न क्षेत्रों (सड़क किनारे और वन क्षेत्र) से संग्रह की गई दस खाद्य खुम्बियों के फल–काय में मिलती भारी धातुओं (सीसा, कैडमियम, तांबा, जस्ता, मैगंनीज, लोहा और निकल) के संकेन्द्रण विनिश्चित किए गए। ये विश्लेषण आणविक अवशोषण स्पेक्ट्रोफोटोमीटर से किए गए। खम्बियों में सीसे, कैडमियम, तांबे, जस्ते, मैंगनीज, लोहे और निकल के सर्वाधिक धातु संकेन्द्रण (शुष्क भार आधार पर) 4.7, 0.84, 59.0, 135.0, 37.0, 1438.0 और 8.6 मिग्रा/किग्रा क्रमश *कोप्रिनस माइकेसियस, क्रोप्रिनस कोमेटस, लायकोपेरडन पायरिफोर्मे, लायकोकोप्रिनस सेपिस्टीपेस, कैन्थारेल्लस साइबेरियस* और *मैक्रोलेपिओटा प्रोसेरा* में मिलते मापे गए। इन परिणामों से संकेत मिला कि कुछ हानिप्रद भारी धातुओं अर्थात कैडमियम और सीसे के स्तर कुछ जंगली खाद्य जातियों जैसे *कोप्रिनस माइकेसियस, कोप्रिनस कोमेटस* और *मैक्रोलेपिओटा प्रोसेरा* में अधिक हैं। इसलिए अधीत क्षेत्र के सड़क किनारे से संग्रह की जानी वाली इन खुम्बियों का खाया जाना कम रखना ही बुद्धिमत्ता होगी।

References

Anderson, A., S.E. Lykke, M. Lange and K. Bech (1982). Trace elements in edible mushrooms. *Publ.* **68**, Stat, Levenedmiddelinst, Denmark. p.29.

Atri, N.S., S.S. Saini and M.K. Saini (1997) Studies on genus *Russula* Pers. from North Western Himalayas. *Mushroom Res.,* **6(1)** : 1-6.

Cuny, D., C. van Haluwyn and R. Pesch (2001) Biomonitoring of trace elements in air and soil compartments along the major motorway in France. *Water Air Soil Poll.,* **125** : 273-289.

Demirbas, A. (2000a) Accumulation of heavy metals in some edible mushrooms from Turky. *Food Chemistry,* **68** : 415-419.

Demirbas, A. (2000b) Proximate analyses and mineral contents of goose and turkey tissues. *Energy Education Science and Technology,* **7** : 67-81.

Demirbas, A. (2001) Heavy metal bioaccumulation by mushrooms from artifically fortified soils. *Food Chemistry,* **74** : 293-301.

Demirbas, A. (2002) Metal ion uptake by mushrooms from natural and artificially enriched soils. *Food Chemistry,* **78** : 89-93.

FAO/WHO, (1976) List of maximum levels recommended for contaminants by the Joint FAO/WHO Codex Alimentarius Commision. Second Series. CAC/FAL, Rome, 3 : 1-8.

Falandaysz, J., B. Sicinska, H. Bona and D. Kohnke (1992) Metal content of *Armillariella mellea. Bromatologia Chemica Toksykologiezna,* **25** : 171-176.

Falandaysz, J., M. Kawano, A. Swieczkowski, A. Brzostowski and M. Dadej (2003) Total mercury in wild grown higher mushrooms and underlying soil from Wdzydze Landscape Parc. Northern Poland. *Food Chemisitry,* **81** : 21-26

Gast, C.H., E. Jansen, J.Bierling and L. Haanstra (1988) Heavy metals in mushroom and their relationship with soil characteristics. *Chemosphere,* **60**(4) : 789-799.

Isildok, O., I. Turkekul, M. Elmastas and M. Tuzen (2004) Analysis of heavy metals in some wild grown edible mushrooms from the middle Black Sea region, Turkey. *Food Chemistry,* **86** : 547-552.

Jorhem, L., and B. Sundstrom (1995). Levels of some trace elements in edible fungi. *Zeitschrift fur Lebensmittel- Untersuchung und-Forschung*, **201** : 311-316.

Kalac, P., J. Burda and I. Staskova (1991) Concentration of lead, cadmium, mercury and copper in mushrooms in the vicinity of a lead smelter. *The Science of the Total Environment,* **105** : 109-119.

Kalac, P. and L. Svaboda (2000) A review of trace element concentrations in edible mushrooms. *Food Chemistry,* **69** : 273-281.

Kalac, P., L. Svoboda and B. Havlickova (2004) Contents of detrimental metals mercury, cadmium and lead in wild growing edible mushrooms : a review. *Energy Education Science and Technology,* **13(1)** : 31-38.

Kojo, M.R. and M. Lodenius (1989) Cadmium and mercury in macro-fungi mechanisms of transport and accumulation. *Angew. Bot.,* **63** : 279-292.

Kuthan, J. (1979) Lead contents in *Boletus aereus* growing along a frequented road in Bulgaria. *Ceska Mykol,* **33** : 58-59 (in German)

Lepsova, A. and V. Mejestrik (1998) Accumulation of trace elements in fruiting bodies of macrofungi in the Krusne Hory Mountains, Czecholovakia. *Science of the Total Environment,* **76** : 117-128.

Lodenius, M., T. Kuusi, K. Laaksovirta, H. Liukkonen-Lija and S. Piepponen (1981). Lead, cadmium and zinc contents of fungi in Mikkeli, SE Finland. *Ann Bot Fennici,* **18** : 183-186.

Moser, M. (1983). *Keys to Agarics and Boleti*. London : Gustav Fischer Verlag.

Purkayastha, R.P. and A. Chandra (1985). *Manual of Indian Edible Mushrooms*. Today and Tomorrow's Printers and Publishers, New Delhi, pp. 12-225.

Quinche, J.P. (1987). Le cadmium un element present en traces dans les sois, les plantes et le champignons. *Revue Suisse Agric.,* **19** : 71-77.

Schmitt, J.A. and H.U. Meisch (1985) Cadmium in mushrooms-distribution, growth effects and binding. *Trace elements in Medicine*, **2** : 163-166.

Schellmann, B., M.J. Hilz and O. Opitz (1980) Cadmium an kopfer ausscheidung nach aufnahme vo champignon-mahlzeiten. *Zeitschrift fur Lebensmittel-Untersuchung und Forschung*, **171** : 189-192.

Sesli, E. and M. Tuzen (1999) Levels of trace elements in the fruiting bodies of macrofungi growing in the East Black Sea region of Turkey. *Food Chemistry,* **65** : 453-460.

Tuzen, M., M. Ozdemir and A. Demirbas (1998) Study of heavy metals in some cultivated and uncultivated mushrooms of Turkish origin. *Food Chemistry,* **63** : 247-251.

Tuzen, M., E. Sesli, A. Demirbas (1999) Levels of heavy metals in the alga of *Ulva lactuca* growing in the Aegean Sea. *Energy Education Science and Technology,* **4** : 21-23.

Vetter, J. (1993) Toxic elements in certain higher fungi. *Food Chemistry,* **48** : 207-208.

Vetter, J. (1994) Data on arsenic and cadmium contents of some common mushrooms. *Toxicon,* **32** : 11-15.