Int J Env Tech Sci 7: 249–252 © 2019 http://www.kalyanishineindia.org/index.php/journal Kalyani Shine India ORIGINAL ARTICLE

Bioaccumulation of several trace metal elements in fungi collected from Gharbia Governorate, Egypt

Mohamed Y A Bedaiwy, Yehia A-G Mahmoud

Tanta University, Faculty of Science, Botany Department, Mycology Research Laboratory, Tanta 31527, Egypt

ARTICLE INFO

Article history:
Received– 01 March, 2019
Revised– 01 April, 2019
Accepted– 02 May, 2019
Available– 12 May, 2019
(online)

Keywords:
Metals
Contamination
Sporocarp
Ganoderma sp.
Bjerkandera sp.
Ganoderma sp.
Inonotus sp.
Abortiporus sp.

Corresponding Author:
Yehia A-G Mahmoud
Email: yehiamah@gmail.com

ABSTRACT

The determination of trace metal elements in fungi is important from an economic point of view, since fungi are used for human or animal consumption and/or as biofertilizers for plants. Furthermore, trace metal concentrations could be a good indicator for soil heath and contamination due to human interference. The present study determined the silver, cadmium, cobalt, chromium, nickel, lead, selenium, zinc and aluminium concentrations in the sporocarps of wild *Ganoderma resinaceum*, *Bjerkandera adusta*, *Ganoderma applanatum*, *Inonotus radiatus* and *Abortiporus biennis* collected from Gharbia Governorate, Egypt, during 2017-2018. The highest zinc concentrations, i.e., values of 39.10 and 42.35 mg kg^{-1}, were recorded in fungi sporocarps gathered from the Zefta and Alsantah urban areas of Gharbia Governorate, respectively. Neither cadmium nor cobalt was observed in the sporocarps of the five species gathered during this investigation period. The aluminium contents of the five studied higher fungi species were higher than the other trace metals contents of these fungi, reaching 3058 mg kg^{-1} dry weight, which might indicate a high risk of contamination with aluminium metals within the air or soil of cities inside Gharbia Governorate, Egypt.

1. Introduction

All over the world, people consume mushrooms every year, particularly in certain nations. However, many wild mushroom species accumulate considerably higher concentrations of trace elements than plants. Approximately forty trace elements have been identified by research to date, with cadmium and mercury being the most important trace metals from the perspective of human wellbeing (Kalač et al. 2003). Several minerals have been reported in higher fungi in different parts of the world. Cadmium, lead, mercury and caesium levels in wild mushrooms have been studied in various territories in the Czech Republic (Cibulka et al. 1996). Additionally, non-metallic components such as phosphorus, selenium, boron, and arsenic were investigated by Vetter (1993; 1994). Cadmium is of interest because of its toxicological significance (Vetter 1993). A high number of metals have shown potential harmful concentrations in wild mushrooms in metal-contaminated territories (Kalac et al. 1998).

The zinc content of mushrooms has been resolved and found that it was varies; Hinneri (1975) and Tolgyesi and Vass (1984) reported zinc contents of 146-155 and 110 mg kg^{-1} dry weight of mushrooms. Mushrooms in Ukraine normally have zinc contents of 100 mg kg^{-1} dry weight (Solomko et al. 1986), and similar values were reported by Vetter (1989) for 80 distinctive Hungarian mushroom tests. Vetter and associates (1997) revealed a normal value of 118.7 mg kg^{-1} dry weight of zinc substances in 363 mushroom tests with samples that were gathered from different territories in Hungary over a multi-year time span. Cadmium, as a metal, is an exceptionally compelling research target due to its toxicological significance (Vetter 1993). Ita et al. (2008) studied the contents of Ni, Cu, Pb,

Mn, Cd and Zn in edible fungal sporocarps and soil from Niger delta wetlands. The results revealed a species-dependent bioaccumulating potential. *Armillariella mellea* had the highest contents of Zn and Pb, while *Pleurotus sapidus* had the lowest bioaccumulating potential for Ni, Pb and Cu. Recently, Bosiacki et al. (2018) studied the contents of selected heavy metals in the fruiting bodies of wild *Agaricus bisporus* (lange) imbach. growing in Poland and concluded that the concentrations of micronutrients (Zn, Cu, Mn, Fe) and pollutants (Cd, Cr, Pb, Ni) were strictly dependent on the sampling sites, as well as the geographical regions of Poland.

The aim of the current study was to evaluate the concentrations of some heavy metals in wild mushroom samples collected during 2017 to 2018 in Gharbia Governorate and to additionally determine whether there is an accumulator species of fungus for these metals.

2. Materials and methods

2.1 Fungal organisms

The fruiting bodies of fungi collected from different localities in El-Gharbia Governorate from April 2017 to April 2018 are presented in Fig. 1. The different genera of wild fungi were found on the trunks of trees, on stumps or on the decayed residues of the dead trees (Table. 1).

2.2 Identification

The collected fruiting bodies were identified according to Phillips (1981), Breitenbach and Kranzlin (1986), Jah (1990), Krueger (2002) and Ostry (2011).

2.3 Sample preparation

Fruiting bodies of fungi were cleaned and dried at 50°C, and then the materials were dried thoroughly with a laboratory grinder. The fine mushroom powders were used for heavy metal analysis (Chapman and Prah 1961). Half a gram of ground mushroom powder was placed in a small beaker. Then, 5 ml of concentrated HNO_3 was added, and the mixture was allowed to stand overnight. Beakers were cooled, and a small amount (1 - 2 ml) of 70% $HCLO_4$ (perchloric acid) was added. The samples were heated again until evaporation to a small volume (0.5 ml) and diluted with distilled water. The trace metal measurements were triplicated and performed by Berkin Elmer Model 2380 in Atomic Absorption Unit, Central Laboratory, at Tanta University.

3. Results and discussion

Ganoderma resinaceum and *Bjerkandera adusta* were collected from Zefta, *Ganoderma applanatum* was collected from Bassiuone, *Inonotus radiatus* was collected from *Kottor, and Abortiporus biennis* was collected from Alsantah (Fig. 1 and 2).

The zinc concentrations measured in mushrooms gathered from Zefta and Alsantah urban areas of Gharbia Governorate were 39.10 and 42.35 mg kg^{-1} dry weight, respectively. Vetter et al. (1997) recorded 118.7 mg kg-^{1} dry weight as a normal zinc content for 363 mushroom samples in his investigation of zinc substances in the Hungarian sporocarps of basidiomycetous parasites over more than three years. In 17 of their samples, the zinc content was more than 200 mg kg^{-1} dry weight. The greatest zinc content was recorded for *Russula atropurpurea* samples, with values of 763-1967 mg kg^{-1} dry weight (Vetter et al. 1997).

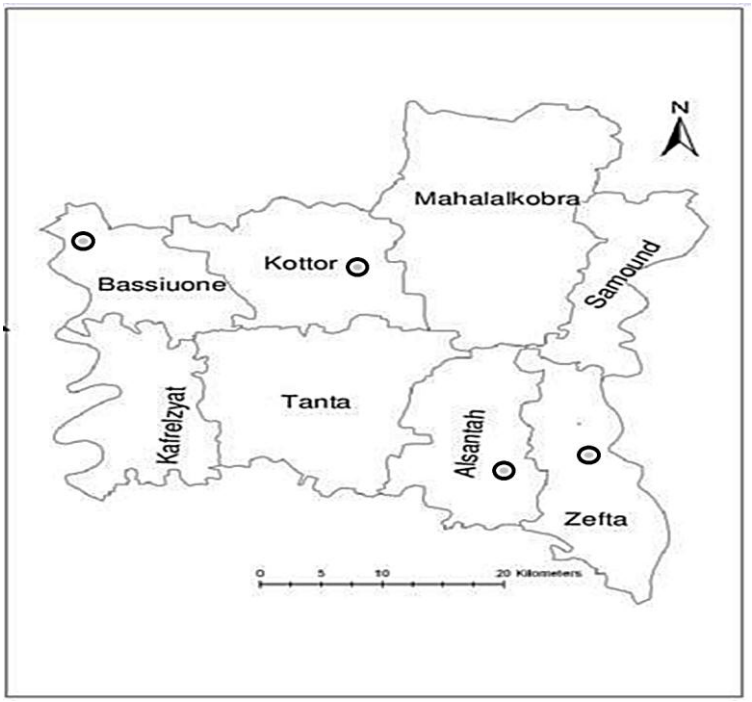

Fig. 1 Map of El-Gharbia Governorate showing the sampling sites (Bassiuone, Kottor, Zefta and Alsantah)

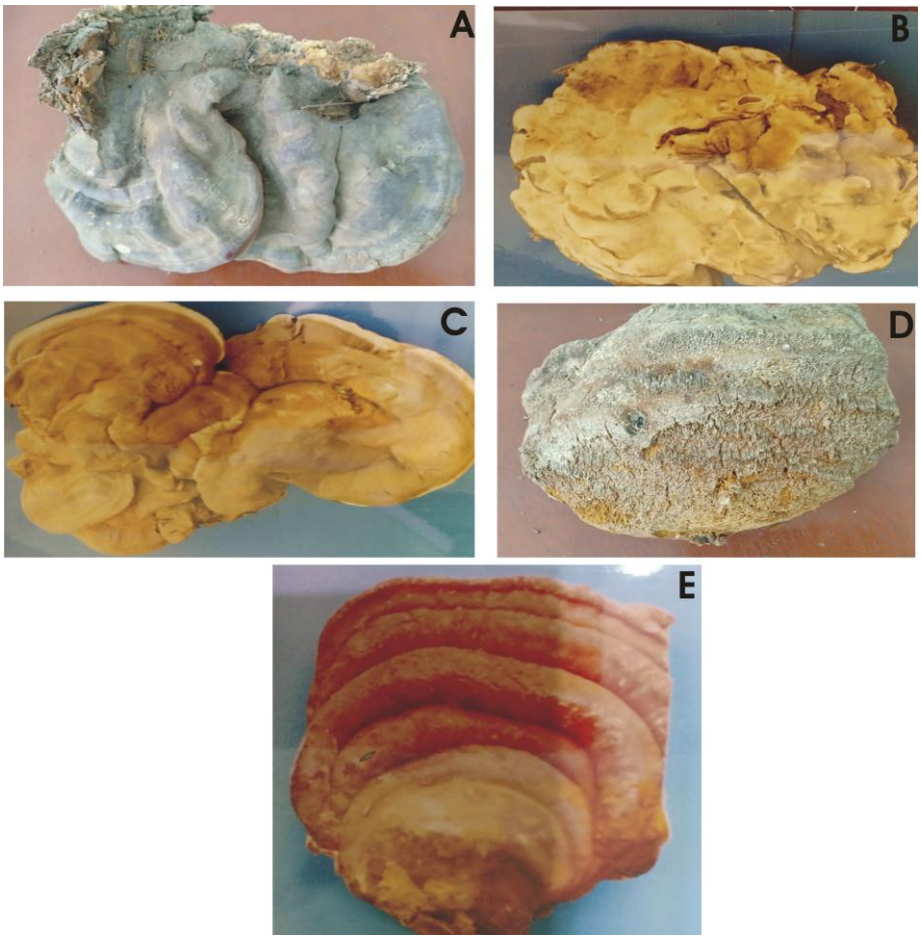

Fig. 2 Photographs of collected fungi - *Ganoderma resinaceum* (A), *Bjerkandera adusta* (B), *Ganoderma applanatum* (C), *Inonotus radiates* (D) *and Abortiporus biennis* (E)

Table 1. Silver, cadmium, cobalt, chromium, nickel, lead, selenium, zinc and aluminium (mg kg^{-1} dry weight) in the sporocarps of collected basidiomycetous fungi collected from Gharbia Governorate (2017 - 2018)

Fungi	**Location**	**Metal concentration (mg kg^{-1} dry weight)**								
		Ag	Cd	Co	Cr	Ni	Pb	Se	Zn	Al
Ganoderma resinaceum	Zefta	0.05	0.00	0.00	1.90	2.20	0. 80	3.30	27.20	253.50
Bjerkandera adusta	Zefta	0. 20	0.00	0.00	1.75	1.000	0. 60	9.05	39.10	224.50
Ganoderma applanatum	Bassiuone	0.05	0.00	0.00	1.55	0. 75	0. 20	0.000	16.30	210.15
Inonotus radiatus	*Kottor*	0.00	0.00	0.00	1.50	0. 70	0.030	0.30	6.15	235.9
Abortiporus biennis	Alsantah	0.00	0.00	0.00	6.350	3.30	1.75	2.70	42.235	3058

Neither cadmium nor cobalt were observed in the sporocarps of the five species gathered from Zefta, Bassiuone, Kottor and Alsantah over 2017-2018 (Table 1). However, Abu El-Souod and collaborators (2000) recorded a cadmium content of 1.655 mg kg^{-1} dry weight in *Ganoderma applanatum*. It is possible that the site where Abu El-Souod and collaborators gathered samples in El-Manssura city, Dakahlaia Governorate, Egypt, is more contaminated than the present study site with cadmium from either the soil or air.Concerning the silver concentrations inside the gathered

sporocarp growths, both *Ganoderma resinaceum* and *Ganoderma applanatum* from Zifta and Bassuione had silver contents of 0.05 mg kg^{-1} dry weight. Again, the analysis of *Bjerkandera adusta* sporocarps demonstrated a silver content of 0.2 mg kg^{-1} dry weight, which may indicate the presence of a type of soil or air contamination with silver. Sporocarps of *Inonotus transmits* and *Abortiporus biennis* of Kotter and Alsantah contained no silver.The lead examination showed that *Abortiporus biennis* sporocarps gathered from Alsantah had the highest lead concentration (1.75 mg kg^{-1} dry weight), demonstrating the high lead contamination of the region. The lowest lead concentrations were observed in fruiting bodies of *Ganoderma applanatum* gathered from Bassiuone (Fig. 1 and Table 1). Garcia et al. (1998) reported that *Coprinus comatus* contains 2.79 ppm of lead.

The chromium investigation showed that *Abortiporus biennis* sporocarps gathered from Alsantah had the most elevated concentration of chromium (6.350 mg kg^{-1} dry weight), demonstrating the high lead contamination of the region.Selenium is an essential component in human health and has all the earmarks of being a key supplement for reducing disease and hindering the progression of HIV. *Bjerkandera adusta* sporocarps gathered from Zefta city contained the greatest concentration of selenium, with a recorded value of 9.05 mg kg^{-1} dry wt.

Surprisingly, aluminium metals of the five gathered sporocarps were recorded as the most astounding concentration all over urban communities of Gharbia Governorates coming to 3.058 g kg^{-1} in the case of *Abortiporus biennis* sporocarp gathered from Alsantah city.

4. Conclusion

The levels of trace metals may be very high in heavily polluted sites, such as near both working and abandoned metal smelters or inside cities. High concentrations of aluminium metals were recorded in *Abortiporus biennis* sporocarps in Alsantah city, exceeding the permissible aluminium content reported in the literature.

References

Abu El-Souod SM, Assawah S, Bedaiwy M (2000) Survey of mushrooms and polypores fungi in Delta region of Egypt. Proc. 1st Int. Conf.Sci. (ICBS) Faculty of Science, Tanta University, 7-8 May, volume (1), 525–545.

Bosiacki M, Siwulski Sobieralski K, Krzebietke S (2018) The content of selected heavy metals in fruiting bodies of agaricus bisporus (lange) imbach. wild growing in Poland. Journal of Elementology 23(93): 875–886.

Breitenbach J, Kranlin F (1986) Fungi in Swizerland. Volume (2) non-gilled fungi Verlag Mycologia, CH-600

Chapman HD, Prah PF (1961) Methods of nalysis of soil, plants, and waters, University of California, USA.

Cibulka J, Sisak L, Pulkrab K, Miholova D, Szakova A, Shmova A, Stehulova I, Arlakova S (1996) Cadmium, lead, mercury, and cesium in wild mushrooms and forest mushrooms and forest berries from different localities of the Czech Repblic. Biology Journal 1 113–129.

Garcia M, Alonso J, Fenandez M, Melgar MJ (1998) .Lead content in edible wild mushrooms in Northwest Spain as indicator of environmental contamination. Arch.Env. contam. Toxicology 34(4): 330–335.

Hinneri S (1975) Mineral elements of macrofungi in oakrich forest on Lenholm island inner archipelago of SW Finland. Ann.Bot. Fennici,12: 135–140.

Ita BN, Ebong GA, Essien JP, Eduok SI (2008) Bioaccumulation Potential of Heavy Metals in Edible Fungal Sporocarps from the Niger Delta Region of Nigeria. Pakistan Journal of Nutrition, 7(1): 93–97.

John R (1953) Mushrooms Toadstool. Collins Clear Press, London and Glasgow.

Kalač P, Svoboda L, Havlíčková B (2004) Contents of cadmium and mercury in edible mushrooms. Journal of Applied Biomedicine 2: 15–20.

Kalac P, Niznanska M, Bewvilaqua D, Sastokava I (1998) Concentrations of mercury, copper, cadmium and lead in fruiting bodies of edible mushrooms in the vicinity of a mercury smelter and a copper semelter. The Science of Total Environment, 177: 251–258.

Krueger D (2002). "Monographic Studies in the Genus Polyporus (Basidiomycotina). " PhD diss., University of Tennessee.

OstryME, Anderson NA, O'Brien J G (2011) Field guide to common macrofungi in eastern forests and their ecosystem functions. Gen. Tech. Rep. NRS-79. Revised February 2017. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 82 p

Pacioni ,G (1981) Guide to mushrooms. Simon and Schuster Publishers, New York.

Phillips R (1981) Mushrooms and other fungi of Great Britain and Europe. Pan Books Ltd., Cavay Place, London SW.

Solomko E.F, Grodzinskaya AA, Paschenko LA, Chelinsteva RK (1986) Mineralnij sostav nekotorih vido kultivirujemih I dikorastusih gribov klassa basidiomycetes. Mikol Fitopatol 20: 474–478.

Tolgyesi G, Vass A (1984). Bazidiumos nagygombal, valamint magvas novenyek asvanyianyag-tartalmanak osszehasonlito vizsgalata. Argoke talajt, 33, 125–133.

Vetter J (1989) Prung des Mineralstoffgehaltes von hoheren Plizen. International Journal of Mycology and Lichenology,4, 107–135.

Vetter J, (1993) Selenium content of some higher fungi. Acta. Alimnetaria, 22: 383–387.

Vetter J, Siller I, Horvath VS (1997) Zinc content of sporocarps of Basidiomycetous Fungi. Mycologia 89(3): 481–483.