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ORIGINAL PAPER

Mineral constituents of edible parasol mushroom *Macrolepiota procera* (Scop. ex Fr.) Sing and soils beneath its fruiting bodies collected from a rural forest area

Edyta Kułdo, Grażyna Jarzyńska*, Magdalena Gucia, Jerzy Falandysz

Research Group of Environmental Chemistry, Ecotoxicology and Food Toxicology, Institute of Environmental Sciences & Public Health, University of Gdańsk, 18 Sobieskiego, 80 952 Gdańsk, Poland

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Concentrations and interrelationships of twenty elements were studied in parasol mushroom and in the top layer of soil (0–10 cm) from the area of Kiwity (Poland). K, P, Mg, Ca, and Zn were found to be the most abundant elements in the mushroom. Higher concentrations of Fe, Mn, Na, Ni occurred in stipes then in caps, while Cd, Cr, Cu, Hg, Rb dominated in caps. Ag, Al, and Ba concentrations in caps and stipes were similar. Parasol mushroom is efficient in up-take and separation of Ag, Cd, Cu, Hg, K (in caps, the bioconcentration factor is BCF $\geq$ 100), Na, P, Rb (50 $<$ BCF $<$ 100), and Mg, Zn (BCF $>$ 10) in its fruiting bodies, while Al, Ba, Ca, Co, Cr, Fe, Mn, Sr, and Pb are eliminated (BCF $<$ 1). Parasol mushroom from rural forest area in the north-eastern region of Poland is of hygienic concern for human health because of toxic mercury and cadmium content in the edible caps, which are also rich in essential Cu, Fe, and their K, Mn, and Zn content is also high.

Keywords: trace elements, food, fungi, wild food, wild mushrooms

Introduction

Fungi in nature are involved in biogeochemical transformation of metallic elements, metalloids, and other chemical elements taken-up from surface mineral soil and humidifying layers and plant biomass or decomposing litter in which mycelium develops. Mushrooms are foods for small animals, game, and many species are edible to man. Mycorrhizal fungi can in part support associated symbiotic plants with minerals absorbed and translocated by their mycelium, while saprophytic species (biomass decomposers) block them entirely from their fruiting bodies (mushrooms, basidiomes, carpophores, sporophores). Analytical data on the mineral profile of fungus fruiting bodies can also help to understand their nutritional and physiological needs and characteristics (Paoletti & Günthondt-Georg, 2006).

Mushrooms are valued for their sensory, nutritional, and medical properties as well as their mineral nutrients composition. They surely do not constitute a significant portion of the food basket worldwide. Nevertheless, consumption of wild grown, and especially of cultivated and medical mushrooms has significantly increased in recent years (Chang, 2006; Falandysz et al., 2011). Cultivated mushrooms are limited to thirty species so far while there are at least two thousands wild grown ones (Chang, 1990, 2006). The intake rates of wild mushrooms vary between the nations (Zhang et al., 2010); however, wild and also cultivated mushroom species are an important ingredient for the local societies and vegetarians' meals worldwide.

Wild grown mushrooms can be rich in metals essential or toxic to humans (Falandysz & Borovička, 2013; Li et al., 2013; Szubstarska et al., 2012). Even species collected from the background (pristine) areas can be abundant in toxic cadmium or mercury (Chudzyński et al., 2009; Melgar et al., 1998). Chem-

*Corresponding author, e-mail: grazyna.jarzynska@gmail.com