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THE EFFECT OF ARSENIC (As) CONTAMINATION ON DOMESTIC VEGETABLES

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ABSTRACT
Elemental arsenic and arsenic compounds are classified as "toxic" and "dangerous for the environment" in the European Union under directive 67/548/EEC. The International Agency for Research on Cancer (IARC) recognizes arsenic and arsenic compounds as group 1 carcinogens, and the EU lists arsenic trioxide, arsenic pentoxide and arsenate salts as category 1 carcinogens. Arsenic is easily absorbed by vegetables from irrigation water. The accumulation of arsenic in vegetables could pose a serious risk on the quality of vegetables and human health. The two forms of inorganic arsenic, arsenate/As(V) and arsenite/As(III), are easily taken up by plant root cells (e.g. *carrot, parsley, kohlrabi*). Once in the cell, As(V) can be readily converted to As(III), the more toxic form of arsenic. In the present research we have determined the level of arsenic contamination in two of the economically most important vegetables grown in Hungary (sweet pepper; tomato) and the irrigation water in an arsenic contaminated area. In order to eliminate arsenic, decontamination was achieved by use of a Japanese-developed special cerium filter.

Keywords arsenic contamination, domestic vegetables, irrigation water, cerium filter

INTRODUCTION

Arsenic (**As**, atomic number33) is a chemical element that occurs in many minerals, usually in conjunction with sulfur and metals, and also as a pure elemental crystal. Arsenic forms colorless, odorless, crystalline oxides, As_2O_3 ("*white arsenic*") and As_2O_5 which are hygroscopic and readily soluble in water to form acidic solutions (CULLEN AND REIMER, 1989). Arsenic is introduced into soil and groundwater during weathering of rocks and minerals followed by subsequent leaching and run off. It can also be introduced into soil and groundwater from anthropogenic sources (AMAYA, 2002). Arsenic was also used in various agricultural insecticides and poisons. For example, lead hydrogen arsenate ($PbHAsO_4$) was a common insecticide previously used on fruit trees, but contact with the compound sometimes resulted in brain damage among those working as sprayers. In the second half of the 20th century, *monosodium methyl arsenate* (MSMA, CH_4AsNaO_3) *and disodium methyl arsenate* (DSMA, $CH_3AsNa_2O_3$) – less toxic organic forms of arsenic – have replaced lead arsenate in agriculture (SZABÓ S. A. ET AL., 1987; NORDSTROM D. K., 2002). The two forms of inorganic arsenic, arsenate/As(V) and arsenite/As(III), are easily taken up by plant root cells (e.g. *carrot, parsley, kohlrabi*). The accumulation of arsenic in vegetables could pose a serious risk on the quality of vegetables and human health (FINNEGAN AND CHEN, 2012). The use of clean water that is free of e.g. arsenic contamination is extremely important for crop production.
During the test forcing period we controlled the arsenic contamination of irrigation water and vegetables. Our aim was to determine the concentration arsenic absorbed from irrigation water in two of the economically most important vegetables in Hungary.

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MATERIAL AND METHOD

Experimental setup

Our measurements and observations were performed in the summer forcing period of 2013, on an area with arsenic contamination fairly above average levels in a private farm in Mezőkovácsháza (*Figure 1*). Vegetable forcing was performed in two neighboring plastic tunnel greenhouses of 50 m length, 9 m width and 450 m^2 floor area each. Sweet pepper and tomato were cultivated and tested in the two plastic tunnel greenhouses, respectively. During the test forcing period a drop irrigation system was used. One half of the plants were irrigated with unfiltered water, while the other half with filtered water. In order to eliminate arsenic, decontamination was achieved by use of a Japanese-developed special *cerium filter* distributed in Hungary by S-Metalltech Ltd. During forcing the Poli-feed complex fertilizer recommended for pepper and tomato forcing was used. Sweet pepper bells and tomato berries in biologically ripe status were harvested. During the test forcing period we have controlled arsenic contamination of both the irrigation water and the vegetables grown. (MSZ EN 14627:2005 6.1. by Food Analytica Kft. Laboratórium, Mezőkovácsháza). Results represent averages of four independent experiments.

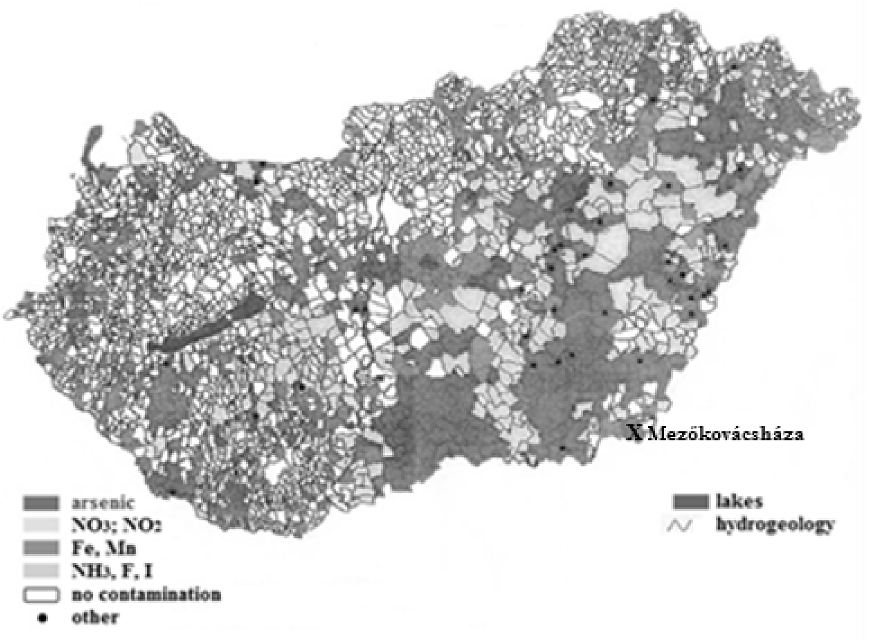

Figure 1. Arsenic contaminated sites of Hungary (OKI, 2007).

Cerium filter

Cerium is the most abundant rare earth element. Monazite and bastnasite ores are at present the more important sources of cerium. Applications: Pollution control technologies such as catalytic converters and fuel additives, glass polishing and UV shielding, water filtration, fluorescent lighting (LOS ALAMOS NATIONAL LABORATORY, USA).

RESULTS

Laboratory assays demonstrated that arsenic concentrations in unfiltered materials were higher than permitted (201/2001. (X.25.) Gev.decree). However, arsenic concentrations in filtered materials were significantly lower (*Table 1*). Our assays demonstrated that arsenic contamination can be easily taken up from irrigation water and absorbed in cells of vegetables. Elevated arsenic concentrations in these crops were not detectable macroscopically, i.e. discoloration caused by arsenic was not observed.

Table 1. Averages of arsenic concentrations in controlled materials (100g)

Controlled materials	Filtered	Unfiltered
irrigation water	>1µg	3,8 µg
sweet pepper (*Capsicum annuum* L.)	1 µg	5,2 µg
tomato (*Solanum lycopersicum* L.)	<0,02 µg	1,9 µg

CONCLUSIONS

Based on literature data it seems that the southern part of the Carpathian Basin is an area of Hungary highly contaminated by arsenic. The primary objective of irrigation water filtering is to achieve production of healthy vegetables. Our research demonstrated that the cerium filter used by us can efficiently clean irrigation water. Levels of arsenic contamination of biological and cultivation factors (sweet pepper, tomato, irrigation water) can be held below toxic levels. By use of the cerium filter tested in this study the consumption of vegetables seems to be safe.

REFERENCES

AMAYA, A. (2002): Arsenic in groundwater of alluvi al aquifers in Nawalparasi and Kathmandu districts of Nepal. Master’s thesis, Dept. of Land and Water Resources Engineering, Kungl Tekniska Hogskolan, Stockholm.

CULLEN W.- REIMER K. J. (1989): Arsenic speciation in the environment. Chem. Rev. 89. 713-764.

FINNEGAN P. M- CHEN W. (2012): Arsenic toxiciti.: The effect of plant metabolism. Front Physiol. 3: 182.

NORDSTROM D. K.(2002): Public Health.-worldwide occurrences of arsenic in ground water. Science 296. 2143-2145.

SZABÓ S. A.- REGIUSNÉ MŐCSÉNYI Á.- GYŐRI D.- SZENTMIHÁLYI S. (1987): Mikroelemek a mezőgazdaságban I. (Esszenciális mikroelemek). Mezőgazdasági Kiadó, Budapest, 1987. 235. ISBN 963 232 468 4.

http://www. Országos Környezetegészségügyi Intézet.hu 2007.

http://www.molycorp.com/resources/the-rare-earth-elements/cerium/