FOOD SECURITY AND ENVIRONMENTAL CHANGES

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Abstract

Determination of some inorganic components, mainly heavy metals, in agricultural crops is frequently required in health-related environmental studies, due to high toxicity of trace amounts of such elements for human organism. The main sources of trace elements to culture plants are their growing media, as soil-water-air ecosystem from which those nutrients are taken up by the root to the foliage. In order to evaluate the anthropogenic contamination of culture crops with toxic elements, samples of different crops and crop parts were analyzed by using photon neutron activation method followed by high resolution γ-ray spectrometry.

The analysis of the elemental concentration data showed always the inputs coming from industrial emissions as well as from fertilizers. For example, the survey showed that in the monitored area bordering a high industrialized urban area there are zones with significantly higher concentrations of Co, Cr, Fe, Mn and Sb and other trace heavy metals and essential elements as Ca, Cr, Cs, Cu, Mo, Na, Pb and Zn linked to the hard industry, urban traffic and agricultural practices.

Keywords: IPNAA, culture plants, anthropogenic contamination

Introduction

We initiated a project the last two years on the theme *Food security and environmental changes* (2009-2011) in order to get knowledge on accumulation of certain elements from the soil in those culture plants since the subsequent intake of them by the consumers might bring a slow hazardous effect to their health. In order to understand the level of risk, if any, posed by trace heavy metal accumulation, it is necessary to trace the "pathway" by which the risk could happens. Some common factors can be identified such as the current levels of heavy

metals in agrisoils, whether these levels are increasing and at what rate, and what factors influence the uptake of heavy metal from soil by crops (so entering the food chain).

The main purpose of the present research was to determine the extent to which industrial inorganic pollutants are transferred to the chosen culture plants belonging to the investigated area in order to establish the quality of the consumed crops. Then the tasks of the present research were connected with the determination of concentrations of essential chemical elements and heavy metals in selected culture plants, namely, A*pium graveolens* and *Petroselinum crispum,* in relation with the growing soil.

Materials and methods

The environmental samples were collected from the agricultural area surrounding the high industrialized town of Craiova. The analyses were carried out on the crop material with a granulation of fractions <2 mm. Aliquots of 2 g of each sample and SRMs (СП-3 and РЖИ) were used for IPNAA analysis. The fresh/dry mass ratio determined for crops were 6.85 and 7.52 for celery pulp and respectively, parsley pulp.

The analytical methodology of IPNAA at MT-25 was largely described in our previous papers (see list of references). Photonuclear reactions and γ lines of some radionuclides in Table 1 are shown.

Results and discussion

Based on the analysis of culture plant samples from various studies, Romanian authorities have a national average baseline (that is, the "natural" background level in crops) levels for chemical constituents, consistent across all regions and soil types. Some results on the concentrations obtained in studied crops are compared with the baseline values as presented in Table 1. Almost in all cases the levels of the elements recorded in plants are under the maximum allowable levels in Romania. However, the overloading normal limit concentration value established in Romania for Fe, Na and Ca in crops was clearly shown.

Element ratios for agricrops and root soil samples were calculated and represented in Figure 1. Relative to the control zone, higher concentrations were found for some essential elements and trace heavy metals in celery and parsley grown on the contaminated soils.

The concentration of elements such as Ca, Co, Cr, Cu, Cs, Fe, Mn, Re, Sb and U in parsley pulp, Co, Cu, Sb and Th in celery pulp, Cr and U in celery peal, and Mn in parsley leaves overload several times the control values.

The model also showed human activity resulted in increased content of some essential and heavy metals concentrations in studied crops and soil in the investigated region.

Table 1. Photonuclear reactions and γ lines of some radionuclides

Element	Reaction	E_{γ}, keV	$T_{1/2}$, d
Cr	$^{52}Cr(\gamma,n)^{51}Cr$	320.1	17.7
Fe	$^{56}Fe(\gamma,n)^{56}Mn$	847	2.6 h
Ni	$^{58}Ni(\gamma,n)^{57}Ni$	1345.8	1.5
Cu	$^{65}Cu(\gamma,p)^{64}Cu$	184.6	2.7 h
Zn	$^{68}Zn(\gamma,n)^{67}$	184.6	243.8
As	$^{75}As(\gamma,n)^{74}As$	595.9 634.8	7.8
Sb	$^{123}Sb(\gamma,n)^{122}S$	564	2.68
Pb	$^{204}Pb(\gamma,n)^{203}P$	279.1	2.171

Conclusion

The piece of work in the considered study under the thematique *Food security and environmental changes* revealed some features of the culture plants grown on the studied territory. Determination of some essential elements and trace heavy metals in chosen crops and their root soil samples collected in investigated area by IPNAA analyses has been accomplished.

The monitoring studies reunited iun this research based on the best-available existing information on "normal" concentration levels in Romania performed a suitable estimation of

the cumulative impact of the anthropogenic emissions on the agricrop production under an industrialized urban area.

Table 2. Significant element concentrations of celery and parsley root sampled in the investigated area

Element	Conc. (mg/g) *Apium graveolens* root	Romanian norms		Conc (mg/g) *Petroselinum crispum* root	Romanian norms	
		Normal	MAL		Normal	MAL
As	0.25±0.06		0.3	0.23±0.04		0.5
Ca	103±7	90		695±38	500	
Fe	17.9±0.6	10		13±6.9	10	
Mn	7.3±0.7			11±1.2		
Na	285±16	200		1460±143	1000	
Zn	8.5±0.7		10	10.3±0.5		15

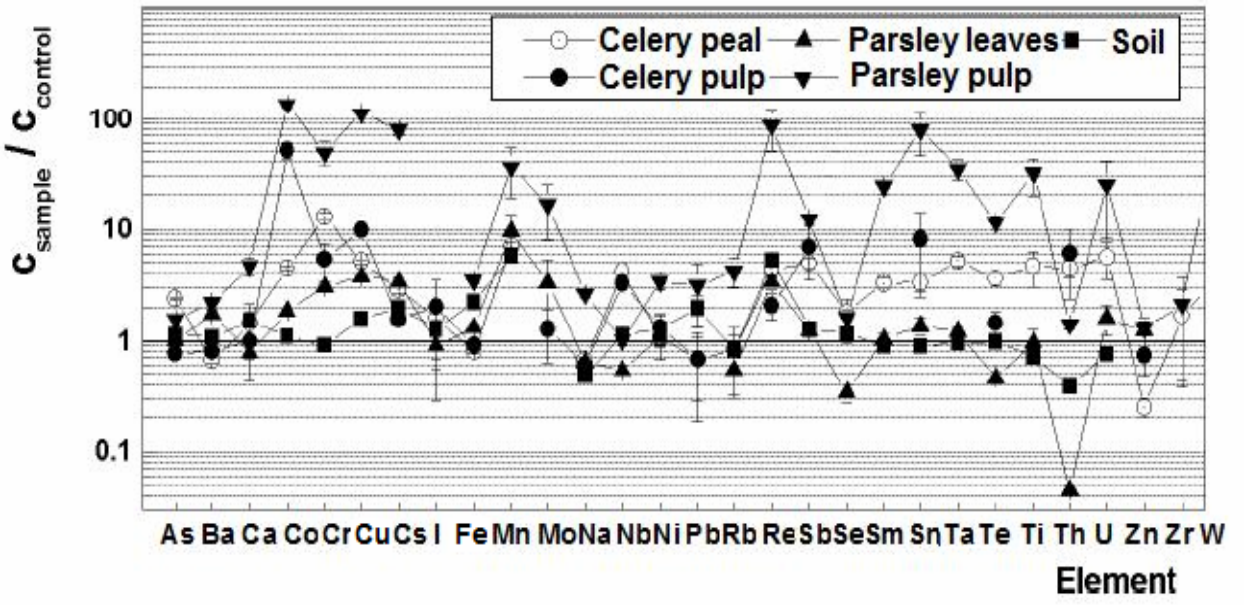

Figure 1. Element concentration factors in studied agricrops versus growing soil

Loading estimates (allowing for losses) in crops and crop parts suggest that the current accumulation rate may gives an indication of uptake trends of the elements in crops grown in different polluted environments. This result seems to be a pattern of the model, but if validated by empirical observation, may have important implications for farm sustainability and its accuracy should be further investigated.

In all cases the metal concentrations found in the culture plants and agricultural soils from the areas studied were less polluted than the maximum allowable (MAL) levels. Therefore they are considered as safe to entering the food chain targeting the human dietary.

References

[1] Abollino, O., Aceto, M., Malandrino, M., Mentasti, E., Sarzanini, C., & Petrella, F., 2002. Heavy metals in agricultural soils from Piedmont, Italy: Distribution, speciation and chemometric data treatment. Chemosphere 49: 545-557

[2] Andrewes, P., Town, R.M., Hedley, M.J., & Loganathan, P., 1996. Measurement of plant available cadmium in New Zeeland soils. Australian J. of Soil Res. 34:441-452

Burau, R.G., 1983. National and local dietary impact of Cd in South coastal California soils. Ecotoxicol. And Environ. Safety 7:53-57

[3] Centre of Ecology and Hidrology, 2002. Economic assessment of crop yield losses from ozone exposure. Contract EPG 1/3/170

[4] Chen, T.B., Wong, J.W.C., Zhon, H., & Wong, M.H., 1997. Assessment of trace metal distribution and contamination in surface soils of Hong Kong. Env. Poll. 96:6-68

[5] Fuhrer, J., & Booker, F., 2003. Ecological issues related to ozone: Agricultural issues. Environ. International 29:141-154

[6] Fuhrer, J., Skarby, L., & Ashmore, M.R., 1997. Critical levels for ozone effects on vegetation in Europe. Environ. Poll. 97:91-106

[7] Garcia-Huidobro, T., Marshall, F.M., & Bell, J.N.B., 2001. A risk assessment of potential agricultural losses due to ambient SO_2 in the central regions of Chile. Atm. Environ. 35:4903.

[8] Holmgren, G.G.S., Meyer, M.W., & Chaney, R.L., 1993. Cadmium, Pb, Zn, Cu and Ni in agricultural soils of the United States of America. J of Environ. Qual. 22:335-348

[9] Mann, S.S., Rate, A.W., & Gilkes, A.J., 2002. Cadmium accumulation in agricultural soils in Western Australia. Water, Air and Soil Poll. 141:281-297

[10] Oprea, C., Maslov, O.D., Gustova, M.V., Belov, A.G., Szalanski, P.J., Oprea, I.A., 2009. IGAA and XRF methods used in oil contamination research. VACUUM 83 1:S162-S165

[11] Oprea CD, Mihul A., 2003. Romanian Rep in Phys 55 32:91-110

[12] Oprea, C., Maslov, O.D., Gustova, M.V., Belov, A.G., Oprea, I.A., Ciofu, R., Mihul, A., 2010. Studies concerning the influence of inorganic pollutants on the quality of agricultural soils. Proceedings of ISINN-17, 91-96

[13] Oprea, C., Gustova, M.V., Maslov, O.D., Belov, A.G., Oprea, I.A., Ion, I., Nedelcu, C. Pirvutoiu, M.G., Vladoiu, D., 2009. Photon neutron activation analysis of the Sea Lettuce algae from the Black Sea, Romania, Proceedings of ISINN-16, 423-429

[14] Pleijel, H., Danielsson, H., Ojanpera, K., De Temmerman, L., Hogy, P., Badiani, M., et al., 2004. Relationships between ozone exposure and yield loss in European wheat and potato- a comparison of concentration and flux-based exposure indices. Atm. Environ. 38:2259-2269

[15] Randa, Z., J. Kucera, L. Soukal. 2001. Possibilities of simultaneous determination of lead and thallium in environmental and biological samples by microtron photon activation analysis with radiochemical separation. J Radioanal Nucl Chem 248 1:149

[16] Sanders, G.E., Skarby, L., Ashmore, M.R., & Fuhrer, J., 1995. Establishing critical levels for the effects of air pollution on vegetation. Water, Air and Soil Poll. 85:189-200

[17] Suarez Varela, M.M., Domingues Lillo, C., & Llopis Gonzalez, A., 1995. A comparative study of mortality in agricultural and industrial areas in Spain. EU J of Epidemiol. 11:633-641

[18] Stalikas, C.D., Mantolovasb, TACh, Pilidis, G.A., 1997. Multielement concentrations in vegetable species grown in two typical agricultural areas of Greece. Sci. Total Environ. 206:17-24

[19] Tokalioglu, S., Kartal, S., 2006. Statistical evaluation of the bioavailability of heavy metals from contaminated soils to vegetables. Bull. Environ. Contam. Toxicol. 76:311-319.

[20] Van Lune, P., Zwart, K.B., 1997. Cadmium uptake by crops from the subsoil. Plant Soil 189:231-237

[21] Vavoulidou, E.E., Avramides, J., Papadopoulos, P., Dimirkou, A., Charoulis, A., Konstantinidou-Doltsinis, S., 2005. Copper content in agricultural soils related to cropping systems in different regions of Greece. Commun. Soil Sci. Plant Anal. 36:759-773.