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THE EVALUATION OF HEAVY METALS CONTENT IN FRUITS AND VEGETABLES USING THE ICP-MS METHOD – (INDUCTIVELY CUPLED PLASMA-MASS SPECTROMETRY)

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Abstract

The aim of this paper was to assess the heavy metals contents of carrots and apples provided from Romanian markets and supermarkets. Arsenic, cadmium, copper, lead and zinc were the heavy metals selected to be analyzed. The amount of heavy metals was determined by using the ICP-MS method (mass spectrometry with inductively coupled plasma. The data showed that metal concentrations are in accordance with concentrations required by low for fresh vegetables and fruits, with the exceptions of zinc content in apple samples.

***Key words**: heavy metals, fruits and vegetables, toxicity,ICP-MS*

INTRODUCTION

Fruits and vegetables are beneficial to our health because they are an important source of nutrients such as vitamins and minerals needed for a balanced life. Vegetable farming is the main source through which these edibles are obtained on an industrial scale, then they are distributed from various suppliers to markets and supermarkets.This is the principal method of how fruits and vegetables arrive on our table for consumption. Due to pollution or chemical fertilizer application, agricultural soils can be altered with heavy metals (Jigau, 1995). Heavy metals are metals and non-metals (chemical elements with electropositive character) that have higher atomic density than 5 g / cm3 and in certain concentrations can have toxic effects and can affect the environment including living organisms. Metals are chemical elements essential for the metabolic processes of living organism, with some exceptions, such as cadmium, lead and mercury, which have not physiological roles, metals are chemical elements essential for the metabolic processes of living organism (Cîmpeanu and Vîrsta, 2011). However, every metals become toxic for human health if metals concentration is exceeding the maximum admissible concentration (MAC) required by low. The metals toxicity occur in low concentrations, on the order of ppm (parts per million). In this context, the paper aims to determine the concentration of metals such as cadmium, lead, copper and zinc, and non-metals as arsenic in fresh vegetables and fruits (apple and carrot) purchased from Romanian markets and supermarkets.

MATERIALS AND METHODS

The samples preparing. The apple and carrot samples were collected from one market and two supermarkets. The samples washed and cleaned by impurities were chopped with ceramic knifes to avoid contamination with metallic materials. Three average samples of apple (and carrot, too) from collected places were prepared. From each average samples 0.5 grams weighed in a Teflon cylinder with an analytical balance were used to establish the amount of heavy metals. Heavy metals analysis. The lab process was conducted in the Research Center for the Study of Quality Food Products - HORTINVEST of University of Agronomical Sciences and Veterinary Medicine from Bucharest. The samples mineralization was obtain using a digester oven. The interaction of microwave radiation

with samples and reagents results in fast heating of reaction mixtures and their efficient decomposition. Advantages of this strategy over conventional procedures are: broad application, much shorter reaction time needed, direct heating of samples and reagents,reduced need for aggressive reagents, minimal contamination and lack of loss of volatile elements (Welna et al., 2011). The samples digestion was carried out at 200 ºC for 15 minutes using 8 ml HNO3 and 2 ml H2O2 as mineralization reagents, and followed by 15 minutes of cooling. The addition of hydrogen peroxide leads to reduction of gas development and allows a better digestion quality and in the same time a reduction of NOx formation (Ethos Up User Manual, 2015). After digestion, the samples were brought to a volume of 50 ml with ultrapure water, and subjected to the analysis.For the final analysis it was used ICP-MS equipment. Mass spectrometry is a technique for determining the mass of an atom or molecule by using the movement of ions in a magnetic or electric fields. Molecular ions and fragment ions are accelerated by the electric field and then separated by diverting a variable magnetic field depending on the mass and their charge and generates an ion current proportional with the abundances of relative ions (Tanaselia, 2013). Finally, the device quantifies the results in data processed by a software program.

RESULTS AND DISCUSSIONS

Cadmium concentration (parts per Billion) of samples is presented in Figure 1.
Usually, cadmium content in plants is between 0.1 and 0.8 ppm. Values greater than 1 ppm are considered toxic. Cadmium toxicity is manifested by lung disease, hypertension, hemorrhagic necrosis selective testicles, sterility, kidney damage and bone damage. The most dangerous form of exposure to cadmium are by air, (by inhaling fine dust and smoke) and by ingestion of cadmium compounds with high solubility.Cadmium can cause pneumonia, pulmonary edema and even death (Hayes, 2007).

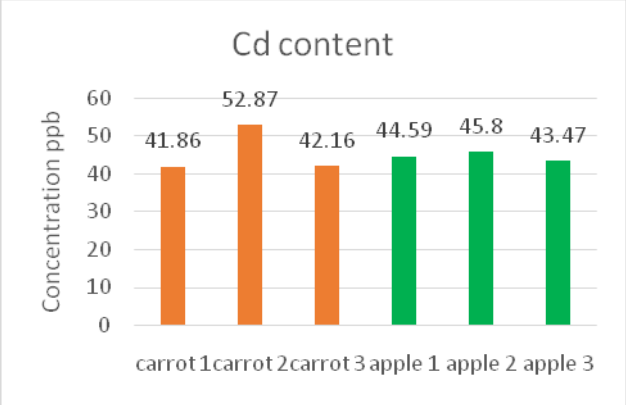

Figure 1. Cadmium content from samples

The absorption of lead in the human body is accomplished slow and it takes place mainly via the gastrointestinal way (and rarely the respiratory tract) in concentration of 5-15%. Chronic toxicity of lead is known from ancient times and is called lead poisoning. The disease is characterized by anemia, neurological disorders (ataxia, seizures, coma), kidney damage (nephropathy chronic Fanconi syndrome), and an increased lead content in blood (Cîmpeanu and Vîrsta, 2011). Lead concentrations in the samples are shown below in Figure 2.

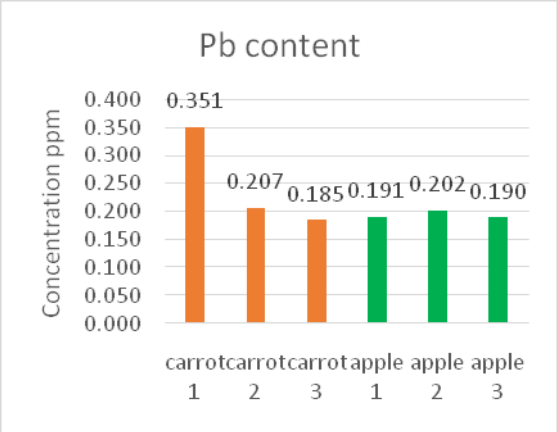

Figure 2. Led content from samples

The arsen has numerous health effects including skin problems, skin cancer, kidneys and lungs cancer, it can damage the blood vessels, but also can cause diabetes, high blood pressure and reproductive disorders.

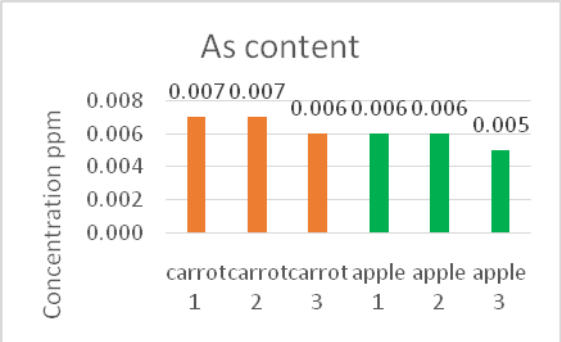

Figure 3. Arsen content from samples

The excess of copper causes the Wilson's disease, manifested by liver cirrhosis, degenerative changes of the lenticular region of the brain, kidney disorders and the occurrence of yellow and green rings in the outer part of the cornea (Underwood, 1977).

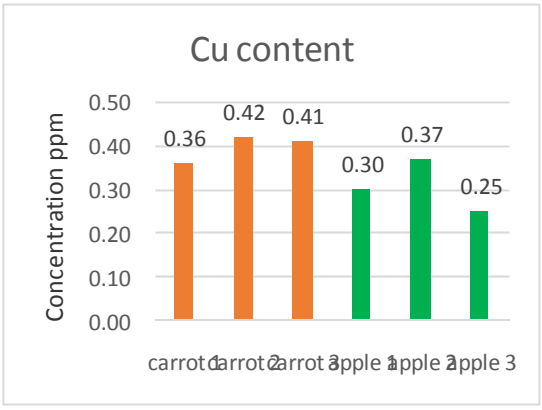

Figure 4. Copper content from samples

Zinc absorption is negatively influenced by: supplements containing iron, high doses of calcium, phytic acid (vegetables and cereals) and alcohol. The excess of zinc can occur both in acute form (fast - after high-dose) and chronic (in time - after multiple doses) .The acute form may occur even 30 minutes after the ingestion of massive doses, and it's manifested by nausea, vomiting, loss of appetite, abdominal cramps, diarrhea and headaches (Cîmpeanu and Vîrsta, 2011).

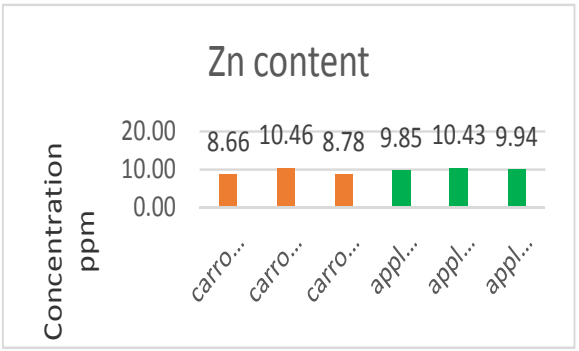

Figure 5. Zinc content from samples

CONCLUSIONS

The comparison between samples and maximum admissible concentrationaccording to the Order no. 975/1998 on the approval of sanitary food (expressed in mg / 1 kg of product) of permitted concentrationper day is shown below in Table 1.

Table 1. The maximum admissible concentation of heavy metals in fruits and vegetables according to Order no. 975/1998 compared with the analyzed samples.

	As	Cd	Pb	Zn	Cu
Vegetables	0,5	0,1	0,5	15	5,0
Fruits	0,5	0,05	0,5	5,0	5,0
Carrot 1	0,007	0,0418	0,351	8,66	0,36
Carrot 2	0,007	0,0528	0,207	10,46	0,42
Carrot 3	0,006	0,0421	0,185	8,87	0,41
Apple 1	0,006	0,0445	0,191	9,85	0,30
Apple 2	0,006	0,0458	0,202	10,43	0,37
Apple 3	0,005	0,0434	0,190	9,94	0,25

In generally, the carrot and apple samples provided from markets and supermarkets have proper contents of heavy metals that not exceed the maximum admissible concentration required by low. However, in apple samples were found Zn concentration values twice higher than maximum concentration allowed for fresh fruits. Also, the cadmium concentration in apple samples (0.044 ppm to 0.045 ppm) were very closely to MAC (0,05 ppm). If a person consumes daily a carrot and an apple (aprox.100 g each) this would lead to an accumulation in the human body of cca. 0,01 mg of Cd, 0.05 mg Pb and 0.1 mg Zn which is ten times under the safe daily dose of 0.1 mg Cd, 0.5 mg Pb, and 10 mg Zn, respectively (FAO/WHO, 2007).

REFERENCES

Cimpeanu C., Virsta A., 2011. Metalele grele in mediul inconjurator, Editura Valahia University Press.

Ethos Up-Operator Manual, 2015.

Grigheli Gheorghe, Nedealcov S; Stasiev Gr; 2005. Procese de poluare a solului cu metale grele si radionuclizi in cadrul landshaftului spatiului dintre Prut si Nistru. Revista factori si procese pedogenetice in zona temperate, Vol. 4, Editura Univ. Al. I. Cuza, Iasi, 145-156.

Hayes A. W., 2007. Principles and Methods of Toxicology, Philadelphia CRC Press, 858-861.

Jigău Gh. V., 1995, Barierele geochimice. Originea şi rolul lor în solificare. Chişinev.

Tanaselia C., 2013. Aplicaţii ale spectrometriei de masă cu plasmă cuplată inductive în analiza metalelor grele din probe de mediu, 1-28, Universitatea Babes-Bolyai, Cluj Napoca.

Underwood R.J., 1977. Trace Elements in Human and Animal Nutrition. Academic Press, New York.

Welna M., Szymczycha-Madeja A., Pohl P., 2011. Quality of the Trace Element Analysis: Sample Preparation Steps, Wide Spectra of Quality Control, Dr. IsinAkyar(Ed.), ISBN: 978-953-307-683-6: http://www.intechopen.com/books/wide-spectra-of-quality-control/quality-of-the-trace-elementanalysis-sample-preparation-steps Control. 61.

http://factori.soilscience.ro/index.php/fspdzt/article/viewFile/318/242

http://www.scritub.com/stiinta/chimie/SPECTROMETRIE-DE-MASA92727.php

http://www.romedic.ro/intoxicatia-cu-arsenic

***Ordinul nr.975/1998, Capitolul VI, Limite maxime de arsen si metale grele in alimente.