

## 4<sup>th</sup> International Symposium on Trace Elements in the Food Chain.

Friends or Foes?

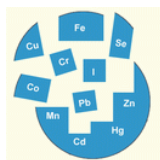
# TEFC 2012

15-17 November 2012  
Hotel Visegrád, Visegrád, Hungary

## Program

## Abstracts

## List of participants



Organiser:

Working Committee on Trace Elements of the Complex Committee  
Hungarian Academy of Sciences

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chair

Balláné dr. Erdélyi Márta  
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dr. Szentmihályi Klára

dr. Fébel Hedvig

dr. Molnár Jeannette

dr. Papp András

dr. Simon László

## **Venue**

Hotel Visegrád \*\*\* – Spa and conference hotel  
2025 Visegrád, Rév u. 15.  
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**Conference Room: 3-4**

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## PROGRAM

### **November 15, Thursday**

**08.00**    *Registration*

**10.00**    *Opening – Professor Mezes Miklos*

**10.15**    **Plenary session**

***Chairperson: András Papp***

TRACE ELEMENTS BIOAVAILABILITY IN TERRESTRIAL ENVIRONMENT: METHODOLOGICAL ISSUES  
*Marija Romić*

RESTORATION OF CONTAMINATED SITES WITH THE AID OF FAST GROWING TREES  
*Pavla Zárubová, Pavel Tlustoš, Stanislava Vondráčková, Jiřina Száková, Daniela Pavlíková*

**11.00**    **Session I – Trace Elements in Air and Water**

***Chairperson: András Papp***

LEAD AND ZINC IN THE SUSPENDED PARTICULATE MATTER AND SETTLING DUST IN  
BUDAPEST, HUNGARY

*Péter Sipos, Emő Márton, Tibor Németh, Viktória Kovács Kis, Zoltán May*

ZINC DEFICIENCY IN SOILS, CROPS AND HUMAN INTAKE – AN EXAMPLE FROM MALI IN WEST AFRICA  
*Birgitta Jacks, Aly Barry, Gunnar Jacks*

**11.30**    ***Coffee break***

**12.00**    **Session II. – Trace Elements in Soil**

***Chairperson: László Simon***

EFFECT OF VARIOUS SOIL AMENDMENTS ON THE MINERAL NUTRITION OF SALIX VIMINALIS  
AND ARUNDO DONAX ENERGY PLANTS

*L. Simon, B. Szabó, M. Szabó, Gy. Vincze, Cs. Varga, Zs. Uri, J. Koncz*

GEOCHEMICAL REGIONS IN HUNGARY — RICH IN, LACK OF?

*Ubul Fügedi, Barbara Kerék, József Vatai*

SORPTION CHARACTERISTICS OF ACTIVATED SLUDGE FOR CO-ZN BINARY SYSTEM

*Vladimír Frišták, Martin Pipiška, Miroslav Horník, Juraj Lesný*

EFFECT OF INDUSTRIAL-COMMUNAL SEWAGE SLUDGE TREATMENT ON THE CD AND CR  
FRACTIONS OF THE SOIL AND ON PLANT UPTAKE IN A POT EXPERIMENT

*Márk Rékási, Tibor Filep, Péter Ragályi, Imre Kádár*

**13.00**    ***Lunch***

**14.30**    **Session III. – Trace Elements in Plants**

***Chairpersons: Klára Szentmihályi, Mihály Szilágyi***

SALINE IRRIGATION WATER AFFECTS ELEMENT UPTAKE BY BEAN PLANT (VICIA FABA L.)

*Matijević L., Romić D., Maurović N.*

ASSESSING PLANTS FOR PHYTOREMEDIATION OF ARSENIC-CONTAMINATED WATER

*María T. Alarcón-Herrera, Esther Llorens, Mario A. Olmos-Márquez, Cecilia Valles-Aragon, Alejandro Benavidez-Montoya*

CONCENTRATION OF CADMIUM IN VEGETABLES GROWN ON CONTAMINATED GARDENS AND PURCHASED VEGETABLES

*Petra Karo Bešter, Franc Lobnik, Ivan Eržen, Marko Zupan*

DETERMINATION OF HEAVY METALS CONCENTRATIONS AND COMPARING BITTER WORMWOOD (ARTEMISIA ABSINTHIUM L.) MEDICINAL PLANT RAW MATERIAL COLLECTED FROM DIFFERENT LOCATIONS IN LITHUANIA

*Povilas Foktas*

ASSESSMENT OF ARSENIC IN RICE, BRAN: ROLE OF ARSENIC LEVEL IN THE SOIL OF BANGLADESH

*Arifin Sandhi, Prosun Bhattacharya, Gunnar Jacks, Maria Greger*

EVALUATION OF RISK ASSESSMENT OF ARSENIC EXPOSURE FROM RICE AND VEGETABLES IN WEST BENGAL, INDIA

*Dipti Halder, Ashis Biswas, Prosun Bhattacharya, Gunnar Jacks, Jerome Nriagu, Debashis Chatterjee*

HOW TO SURVIVE EARLY TOXIC COPPER EXCESS?-BIOCHEMICAL AND ANATOMICAL CHANGES DURING GERMINATION OF INDIAN MUSTARD

*Réka Szöllősi, Erika Kálmán, Anna Medvegy, Ilona Sz. Varga*

**16.20 Coffee break**

**17.00 Session III. – Trace Elements in Plants (continued)**

UNIQUE METABOLISM OF SELENIUM IN HERICIUM ERINACEUS (HEDGEHOG MUSHROOM)

*Orsolya Egressy-Molnár, Júlia Gyórfi, Mihály Dernovics*

QUADRUPLE IMMUNE RESPONSE OF PLANTS TO PATHOGENS AFTER PRETREATMENT WITH DIFFERENT DOSES OF TRACE ELEMENTS

*Ernő Tyihák, Ágnes M. Móricz, Mihály Szilágyi, Ferenc Billes*

EFFECT OF MICROELEMENTS ON ALFALFA ON A SANDY SOIL

*Péter Ragályi, Márk Rékási, Imre Kádár*

**17.45 Session IV – Trace elements in Animals**

**Chairperson: Miklós Mézes**

DEPOSITION OF ORGANIC TRACE METAL COMPLEXES AS FEED ADDITIVES IN FARM ANIMALS

*Mézes M., Erdélyi M., Balogh K.*

EFFECT OF COBALT-EDTA ON IRON CONTENT IN SPLEEN AND LIVER OF IMMATURE MICE

*Yordanka Gluhcheva, Ekaterina Pavlova, Vasil Atanasov, Juliana Ivanova, Ivelin Vladov, Sonja Ganeva, Mariana Mitewa*

THE FATE OF NANOSELENIUM IN THE SOIL-PLANT-ANIMAL SYSTEM

*József Prokisch, Péter Eszenyi, Tímea Takács, Beáta Babka, Éva Szabolcsy, Andrea Balláné Kovács, Ilona Benkő, Miklós Fáry, Attila Sztrik*

**18:30 Session of the newly established working group**

**20.00 Welcome reception** in the Restaurant of the Hotel

## **November 16, Friday**

### **08.30 Session V – Trace Elements in Chemistry**

**Chairperson: Mihály Dernovics**

ADVANTAGES AND DISADVANTAGES OF ARSENAZO III AND CHLOROPHOSPHONAZO III UTILIZATION FOR SPECTROPHOTOMETRIC Th DETERMINATION

*Jozef Uhrovčík, Maroš Juraška, Juraj Lesný*

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*Edit Sárközi, Levente Kardos, Panna Sepsí, Márta Ladányi, László Tőkei*

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*Emese Ficsor, Klára Szentmihályi, Éva Lemberkovics, Anna Blázovics, Andrea Balázs*

NON-USUAL WAY OF SELENIUM-METABOLOMICS: SEARCHING FOR THE INFLUENCED PATHWAYS

*József Lénárt, Júlia Győrfi, Attila Hegedűs, Mihály Dernovics*

ELECTRON PARAMAGNETIC RESONANCE SPECTROSCOPY TO DETERMINE STRUCTURAL AND SOLUTION EQUILIBRIUM DATA; COMPLEXATION OF SALICYLALDEHYDE SEMICARBAZONE WITH Cu(II) AND VO(IV)

*Nóra V. Nagy, Éva A. Enyedy, Gabriella M. Bognár, Tamás Kiss, Dinorah Gambino*

HEAVY METAL DISTRIBUTION OF FLOODPLAIN SOILS AND PASTURES OF THE TISZA RIVER

*Zoltán Győri, Norbert Boros, Emese Bertáné Szabó, Péter Sipos*

MINERAL CONTENT OF HERB VARIETIES ON A FLOODPLAIN PASTURE BY THE TISZA RIVER

*Zoltán Győri, Norbert Boros, Diána Ungai, Péter Sipos*

CHEMICAL WATER QUALITY CHANGES ALONG A STREAM AT AN ABANDONED PB-ZN MINING SITE

*Elza Kovács, Dario Omanović, Ivanka Pižeta, Halka Bilinski, Stanislav Frančišković-Bilinski, János Tamás*

### **10.30 Coffee break**

### **11.00 Session VI – Trace Elements in Biology and Medicine and Food**

**Chairperson: Janette Molnár**

INVESTIGATION OF EFFECTS OF TWO ENVIRONMENTAL HEAVY METALS IN A COMBINED EXPOSURE MODEL ON THE NERVOUS SYSTEM IN RATS

*András Papp, Edina Horváth, Zsuzsanna Máté, Andrea Szabó*

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*Klára Szentmihályi, Zoltán May, Anna Blázovics*

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*Zsuzsanna Elekes, Magdolna Dank, Eszter Mátis, Krisztina Süle, Anna Blázovics, Andrea Balázs*

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*Eszter Mátis, Dénes Kleiner, Krisztina Süle, Klára Szentmihályi, Ágnes Szilvás, Zsuzsanna Elekes, Anna Blázovics*

CLINICAL ACTIVITY SCORES ARE IMPROVING IN PATIENTS WITH MILD GRAVES' ORBITOPATHY RECEIVING ADJUVANT SELENIUM SUPPLEMENTATION

*Jeannette Molnár, Csaba Balázs*

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*Michaela Kröppl, Michaela Zeiner, Iva Juranovic Cindric, Gerhard Stingeder*

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*Michaela Zeiner, Iva Juranovic Cindric, Michaela Kröppl, Gerhard Stingeder*

**13.00 Lunch**

**14.30 Poster Session**

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*Erzsébet Krausz, Judit Vallner, Judit L. Halász*

INFLUENCE OF CADMIUM AND MONENSIN ON RENAL AND CARDIAC FUNCTION OF MICE, SUBJECTED TO SUBACUTE CADMIUM INTOXICATION

*Juliana Ivanova, Yordanka Gluhcheva, Sonja Arpadjan, Mariana Mitewa*

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*Ildikó Kiss, András Kádár, Béla Kovács, János Mátyus, István Kárpáti, József Balla, Zsuzsa Varga*

AMMONIUM VANADATE REDUCES VIABILITY AND PROLIFERATION OF CULTURED VIRUS-TRANSFORMED CHICKEN HEPATOMA CELLS

*Abdulkadir Mahdi Abudalleh, Tanya Zhivkova, Lora Dyakova, Yordanka Gluhcheva, Radostina Alexandrova*

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*Ekaterina Pavlova, Juliana Ivanova, Donika Dimova, Yordanka Gluhcheva, Nina Atanassova*

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*Ekaterina Pavlova, Maria Madzharova, Donika Dimova, Yordanka Gluhcheva, Nina Atanassova*

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*István Fekete, Nándor Rakonczás, Dávid András, Éva Bódi, Béla Kovács*

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*Zita Burján, Mariann Mór, Béla Kovács, Zoltán Győri*

OIL SEEDS AS SOURCES OF SELENIUM

*Xénia Vágó, Kinga Nagy, Zita Burján, Dávid András, Béla Kovács*

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*Nikolett Czipa, Zita Burján, Dávid András, Béla Kovács*

MICROELEMENTS IN DRUG AND TEAS OF PLANTAGO LANCEOLATA L.

*Mária Rábai, Nóra Veronika Nagy, Zoltán May, Klára Szentmihályi*

EVOLUTION OF BIO-ACTIVE SUBSTANCES IN ASPARAGUS AS AFFECTED BY DIFFERENT HARVEST TIMES

*Takácsné Hájos Mária, Kiss Péter, Borbélyné Varga Mária, Zsombik László*

SYNTHESIS OF A SELENOCYSTEINE PEPTIDE FOR QUALITY CONTROL PURPOSES

*Andrea Vass, Anikó Német, Mihály Dernovics, Anna Magyar*

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*Attila Tomócsik, Viktória Orosz, Tibor Aranyos, Marianna Makádi, György Füleky*

NEW SELENIUM SOURCE AS A POTENTIAL FEED ADDITIVE IN POULTRY NUTRITION

*Márta Erdélyi, Zsolt Ancsin, Krisztián Balogh, Attila Sztrik, József Prokisch, Miklós Mézes*

BIOCHAR PROPERTIES FROM DIFFERENT MATERIALS OF PLANT ORIGIN

*Kateřina Břendová, Pavel Tlustoš, Jiřina Száková, Jan Habart*

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*Alžbeta Hegedúsová, Silvia Jakobová, Ondrej, Hegedús, Magdaléna Valšíková, Anton Uher*

**16.00 Social program and Gala Dinner**

The program begins with a short drive to the Citadel of Visegrád. We will have a short stroll there, enjoying the view to the Danube Bend.

The next stop is the Royal Palace of King Matthias, a guided tour presents all the stories of the Renaissance King and the Medieval Ages. After walking around the Palace, pálinka (a special Hungarian spirit) with grilled marron will be served in the coffee bar of the Museum.

We will proceed to the Solomon's tower, to see the Knights' tournament. On the call of the king, the knights march in and show their targeting and fighting skills with medieval weapons to the royal couple and their guests. The realistic face-to-face battles recall the courage and spirit of the medieval knights in an exciting way with a bit of humour.

During the program, you will be offered hot wine and tea.

The tournament is followed by a royal feast in a Renaissance Restaurant, you will march to the restaurant led by drummers.

After the dinner, transfer to the hotel.



## **November 17, Saturday**

### **09.00 *Guided Excursion to Esztergom***

During the sightseeing tour our guests have the opportunity to see the Basilica and the Crypt on a historic walking tour.

On the Castle hill the medieval walls, the bastions and the gates remained in a good condition In the so-called „Up-Castle” can be seen the royal bishop’s palace, the remains of the chapel, the eastern barbican, the turkish bastion and the chapel of the castle.

After lunch, you will be transferred back to Visegrád.



## **ABSTRACTS**

## **TRACE ELEMENTS BIOAVAILABILITY IN TERRESTRIAL ENVIRONMENT: METHODOLOGICAL ISSUES**

**Marija Romić**

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Beside anthropogenic sources, trace metals can be found in the parent material from which the soils develop. Whether these inputs will become toxic and to what degree mobile depends on a number of factors: specific chemical and physical trace metal characteristics, soil type, land use, geomorphological characteristics within the soil type and exposure to emission sources. Processes that control the mobility, transformation and toxicity of metals in soil are of special importance in the soil root developing zone – the rhizosphere. For this reason, there is a considerable interest in understanding trace metals behaviour in soil, with special emphasis on the way they enter the soil and on processes by which plants take them up. Full understanding and prediction of chemical behaviour of an element in the environment is possible only by identification of all forms in which that element can be found under different environmental conditions. Various chemical methods, geochemical models and biotests are used for assessment of the bioavailable metal fraction in soil. However, these methods are not universally applicable for all elements and different soil characteristics. Chemical methods for assessment of metal bioavailability are commonly grouped within methods for identification of total metal content in soil, methods for assessment of currently available and potentially available fractions, as well as methods for prediction of metal speciation in soil solution. This article offers a critical review of methodologies available for assessing metal speciation in solid and liquid phases in soils taking into consideration the array of parameters that might influence uptake and effects upon the plant.

## **RESTORATION OF CONTAMINATED SITES WITH THE AID OF FAST GROWING TREES**

**Pavla Zárubová<sup>1</sup>, Pavel Tlustoš<sup>1</sup>, Stanislava Vondráčková<sup>1</sup>, Jiřina Száková<sup>1</sup>, Daniela Pavlíková<sup>1</sup>**

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Soil is basic means of agricultural production and subsequently the source of food for human population. Soil degradation and contamination belong among big global issues. Several remediation techniques have been tested to restore contaminated land and to keep soil properties on the sufficient level for the food production. Success of designed procedure is affected by metal presence and level of contamination. In battery of experiments the ability of willows and poplars to extract metals from moderately and heavily metal-contaminated sites was investigated as well the influence of organic fertilizers application on biomass production and a heavy metal uptake. The ability to accumulate risk elements has been proved, cadmium showed the best performance. Furthermore, a significant influence of biomass production on the total uptake of risk elements was proved. Organic fertilization had a negative effect on the metal uptake. Extremely contaminated soils can not be directly cleaned by plant, they mainly need chemostabilization treatment before planting of trees.

## LEAD AND ZINC IN THE SUSPENDED PARTICULATE MATTER AND SETTLING DUST IN BUDAPEST, HUNGARY

Péter Sipos<sup>1</sup>, Emő Márton<sup>2</sup>, Tibor Németh<sup>1</sup>, Viktória Kovács Kis<sup>3</sup>, Zoltán May<sup>4</sup>

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Urban airborne particulate matter and dust can be both ingested and inhaled so they may cause health damage due to their size, shape or toxic components. Our aim was to characterize the concentration, enrichment and host phases of lead and zinc in the total suspended particulate matter and settling dust in Budapest, Hungary. Total suspended particulate matter samples were collected from the air filters placed in the respiration channels of thermal power stations. Settling dust samples were collected in glass pots containing distilled water next to a busy street. Detailed mineralogical (XRD, TEM), chemical (XRF) and magnetic susceptibility analyses were carried out on the samples.

Both Pb and Zn showed moderate to heavy contamination in both kinds of samples with enrichment factors up to 6.7 for Pb and 5.3 for Zn. The concentrations of Pb were generally higher in the settling dusts (50-6011 mg/kg) than in the suspended matter (394-699 mg/kg) while its reverse was found for Zn (374-7715 mg/kg in the settling dust and 1342-19046 mg/kg in the suspended matter). Transmission electron microscopy analyses showed that magnetite contained significant amount of Zn and Pb. However, these metals could be also associated to layer silicates (smectites, micas) and Ca-carbonates. Moreover, Zn also appeared as major phase constituent in carbonates and oxides. Magnetite particles are resistant to weathering releasing its toxic components slowly to the environment, while layer silicates (and carbonates) may be the potential source of mobile toxic metals in the studied materials in Budapest.

The project was financially supported by the OTKA (K76317 and K75395).

## ZINC DEFICIENCY IN SOILS, CROPS AND HUMAN INTAKE – AN EXAMPLE FROM MALI IN WEST AFRICA

Birgitta Jacks<sup>1</sup>, Aly Barry<sup>2</sup>, Gunnar Jacks<sup>1</sup>

<sup>1</sup>Åbo Akademi, FIN-20500 Turku, Finland; <sup>2</sup>Fondation Novartis, Segou, Mali

Zinc deficiency is the most common trace element deficiency in soils. Zinc deficiency may affect the yield and it may lead to insufficient intake of zinc by humans (Sanchez & Swaminathan, 2005). This is especially serious for children as zinc deficiency affects the immune system and it has been assessed the about 20 % of child mortality in Sub-saharan Africa is due to zinc deficiency (Bryce et al., 2005). About 40 % of the Indian agricultural soils are zinc deficient . An investigation in Coimbatore showed just this figure (Rex & Vestin, 2005). Zinc deficiency is common in many tropical countries. The reasons for zinc deficiency may be low inherent zinc content, low availability due to a high pH or less common due to excess phosphorus fertilisation.

This investigation was done in the Niger inland delta at five sites along a stretch of 600 km of the river Niger. There was almost complete zinc deficiency in agricultural fields, only garden soil inside villages had higher available zinc, presumably due to long term flux via food and animals to villages from the cultivated fields. Wheat has given low yields probably due to zinc deficiency. The availability of zinc in cereals is restricted by phytate, a carrier in the grains of phosphorus but also of trace metals like zinc, iron and copper (Gibson, 2005). The molar ratio of zinc/phytate in most cereals exceeds 15, which is considered as a low availability of the zinc (Gibson, 2005). As the diet is largely dominated by cereals with less than 10 % of food items of animal origin the food intake of zinc is just about half of the recommended This may have serious consequences for children, especially at weaning when they switch from breast milk to the food of the family. An investigation shows an accumulated number of deaths at weaning age (Jacks et al., 2010).

The phytate is degraded by an indigenous enzyme in the grains while soaking and germination improves the zinc availability or fermentation. Some food items are fermented like soumbala, grains from the tree *Parkia biglobosa*. A major need is a weaning food with a low phytate/zinc ratio, and a first composition have been tested and found to have a fairly good availability. Another fairly zinc rich food is a tea prepared of the flowers of *Hibiscus subdarifa* which contains no phytate.

### References

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- Gibson RS. (2005) *Principles of nutritional assessment*. 2<sup>nd</sup> ed., New York, Oxford University Press.
- Rex J, Vestin A-S. (2005) *The effects of alkaline soil and water on crop and human nutrition. A case study of Zn, Cu Mo and F in Pooluvapatty, Coimbatore, India*. M Sc thesis, Linköping University, Sweden.
- Sanchez PA, Swaminathan MS. (2005) Hunger in Africa: the link between unhealthy people and unhealthy soils. *Lancet* **365**:442-444.

## EFFECT OF VARIOUS SOIL AMENDMENTS ON THE MINERAL NUTRITION OF *SALIX VIMINALIS* AND *ARUNDO DONAX* ENERGY PLANTS

L. Simon<sup>1</sup>, B. Szabó<sup>2</sup>, M. Szabó<sup>2</sup>, Gy. Vincze<sup>1</sup>, Cs. Varga<sup>1</sup>, Zs Uri<sup>1</sup>, J. Koncz<sup>3</sup>

<sup>1</sup>Department of Land Management and Rural Development, <sup>2</sup>Department of Agricultural Science, College of Nyíregyháza, H-4400 Nyíregyháza P.O.Box 166. Hungary. Email: [simonl@nyf.hu](mailto:simonl@nyf.hu); <sup>3</sup>Hungarian Academy of Sciences, Centre for Agricultural Research, Institute of Soil Science and Agricultural Chemistry, H-1022 Budapest, Herman O. str. 15., Hungary

Basket willow (*Salix viminalis* L. cv. Inger) and giant reed (*Arundo donax* L.) energy plants were grown in open-field experiments. The brown forest soil (loamy sand texture, pH<sub>KCl</sub> 7.5, humus 1.5%, CEC 10.4 cmol<sub>c</sub>/kg; As-38.3, Cd-0.11, Cu-12.7, Pb-13.6, Zn-44.3 mg/kg in HNO<sub>3</sub>/H<sub>2</sub>O<sub>2</sub> extract) was treated with a fertilizer and various soil amendments (ammonium nitrate–AN: 100, 150, 300 kg/ha; municipal sewage sludge compost–MSSC: 15, 25 t/ha; municipal biocompost–MBC: 20, 25 t/ha; rhyolite tuff–RT: 30 t/ha; willow bioash–WB: 600 kg/ha), and with their combination in 4 replications.

Three months later, in the leaves of treated *Salix* cultures (except WB application) 9.8-23.5% more N was detected than in untreated controls. Most of the treatments enhanced the uptake of K, but concentration of P, Mg, Ca, Fe and Zn in leaves was reduced. Highest As concentrations (1.92-2.11 µg/g) were found in WB-treated cultures. Cd concentration in treated leaves (0.34-0.57 µg/g) was lower than in controls (0.99 µg/g), while Pb concentrations were under the detection limit.

Eighteen weeks after soil treatments mostly MSSC application influenced the accumulation of macro- and micronutrients in the leaves of *Arundo*, where slightly more N, less Ca, Mg, and Mn was found, than in controls. Concentrations of Cd, Cu, Pb and Zn were similar to control. Thirty four weeks after soil treatments 11% more N, 35% more P, 205% more K, and 37% more Zn was detected in the shoots of *Arundo*, treated with MBC. MSSC, or MBC+AN application enhanced the Cd accumulation in giant reed shoots by 20 or 25%, respectively.

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## **GEOCHEMICAL REGIONS IN HUNGARY — RICH IN, LACK OF?**

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The sediments are continuously weathering on accumulative surfaces. The bigger amount of ions, those getting into solution, are transported to the sea by the River Danube, so the greater part of soils in Hungary are poor in nutrients. The geochemical heterogeneity of the surface was formed by the processes in geological recent past and historical past.

The larger part of the country belongs to the “main” region 1. That region does not show a characteristic association of elements, i.e. the dominant part of the variations resulted from processes of accumulation and leaching, connected to the grain size distribution of the parent material.

In Central Hungary (the “limy” region 2) limy soils are present. In the ice-age, when the precipitation was fewer than nowadays and the vegetation set the soil less, the wind blew the dust of carbonate rocks covered the main part of the Transdanubian Range far away. The crystalline limestone- and dolomite dust gradually dissolve in the unsaturated zone and it precipitates in the pores, while other elements are crowded out, so the micro-nutrient supply of the soil became deficient.

Near the western border line, the surface sediments of the “ferrous” region 3 are transported from the Alpine belt by different surface waters. Since the watershed of those surface waters are dominated by basic and ultrabasic rocks, iron alloy metals (Fe, Cr, Co and Ni) are characteristic in this region.

In the flood-plain deposits of rivers discharging from Transylvanian mining areas and from some heavy industrial centres of North (“eastern” region 4) we can find characteristic Pb-, Cd-, Cu-, Zn-, As- and Ag-concentrations. The anomalies in the overbank sediments of lower courses sometimes are higher, than the threshold limit, not just on the surface, but in the depth of a few decimetres.

## SORPTION CHARACTERISTICS OF ACTIVATED SLUDGE FOR Co-Zn BINARY SYSTEM

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Toxic and radiotoxic metals of liquid wastes are sorbed by the sludge of waste water treatment plants (WWTPs) with a high efficiency. Sludges with low toxic metals concentrations can be temporally stored or utilized as soil conditioners in agriculture. Other possible and economically acceptable way is repeated utilization of the sludge as heavy metals sorbent. Since effluents can contain several metals, it is necessary to study the simultaneous sorption of two or more metal ions and also to quantify the mutual effect of one metal on the other. In the present study, we investigated sorption characteristics of dried activated sludge (DAS) from industrial WWTP for sorption  $\text{Co}^{2+}$  and  $\text{Zn}^{2+}$  ions from their binary aqueous system in batch experiments using radiotracers  $^{60}\text{Co}$  and  $^{65}\text{Zn}$  technique. Values of maximum sorption capacity ( $Q_{max}$ ) of DAS at pH 6 calculated from extended Langmuir adsorption isotherm were  $247 \pm 15 \mu\text{mol/g}$  for  $\text{Co}^{2+}$  and  $479 \pm 32 \mu\text{mol/g}$  for  $\text{Zn}^{2+}$  ions. Results revealed that the sorption capacity of DAS for both metals increases with increased initial concentration in range 100 – 4000  $\mu\text{mol/dm}^3$   $\text{CoCl}_2$  and  $\text{ZnCl}_2$ , respectively. Presence of  $\text{Zn}^{2+}$  ions as co-ions caused more significant decrease of  $\text{Co}^{2+}$  uptake in binary Co-Zn system than vice versa. Experimental data of Co and Zn sorption in binary system were well described by extended Langmuir model and affinity parameter  $b$  indicate higher affinity of DAS to  $\text{Zn}^{2+}$  in comparison with  $\text{Co}^{2+}$  ions. Prediction of total Co-Zn sorption by DAS using extended Langmuir model was less suitable due to dissimilarity of  $Q_{max}$  value of DAS for  $\text{Co}^{2+}$  and  $\text{Zn}^{2+}$  in single systems.

## **EFFECT OF INDUSTRIAL-COMMUNAL SEWAGE SLUDGE TREATMENT ON THE CD AND CR FRACTIONS OF THE SOIL AND ON PLANT UPTAKE IN A POT EXPERIMENT**

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The Cd and Cr fractions (mobile: 1M NH<sub>4</sub>NO<sub>3</sub>-soluble, mobilisable: ammonium acetate + EDTA-soluble, “total”: cc. HNO<sub>3</sub> + cc. H<sub>2</sub>O<sub>2</sub>-soluble) of the experimental soils and the Cd and Cr contents of spring barley grain and straw were examined in a pot experiment to investigate the effect of applying industrial-communal sewage sludge with metal contents exceeding the authorised limit. The four experimental soils were acidic sand, calcareous sandy soil, calcareous chernozem loamy soil and brown forest soil, or acidic loam. The sludge was applied at rates of 0, 2.5, 5, 10 and 20 g sludge D.M. /kg air-dry soil in four replications. The results showed that in contempt of literature data the concentration of mobile Cd fraction was mostly affected by soil texture and not the pH. Regression analysis on the soil Cr and Cd fractions and the barley grain and straw element contents revealed that in the case of Cd the soil mobile fraction is the most suitable to predict the plant concentration. The changes in plant Cr concentrations were not coherent, thus the regression with soil Cr concentration did not give reliable results. Only a negligible proportion of the elements added with the sludge appeared in mobile form in the soil. This ratio is smaller in the case of Cr where only 0.02 % of the sludge Cr content can be found in the soil mobile Cr fraction. Since Cd is more mobile element 2.5 % of the added Cd can be found in the mobile fraction. Our results indicated that in case of sewage sludge application on field it is important to consider not only the element contents, but also other parameters (pH, CaCO<sub>3</sub>%, organic matter), as these may influence the dissolution of contaminants.

## **SALINE IRRIGATION WATER AFFECTS ELEMENT UPTAKE BY BEAN PLANT (*VICIA FABIA* L.)**

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Using of saline water for agricultural irrigation is leading towards salt accumulation in the root zone and consequent damage to crop production and soil fertility. Furthermore, it is known that increased root zone salinity can potentially increase plant trace element uptake. In this context, crop salt tolerance and growth response assessment is useful tool in managing salinity stress. A greenhouse pot experiment was set up to study the effects of irrigation water salinity on growth and element uptake of faba bean (*Vicia faba* L.).

Three weeks old faba bean seedlings were transplanted into pots and automatically fertigated with a modified Hoagland nutrient solution. Two weeks after transplanting, treatment with four NaCl salinity concentrations in nutrient solution was applied as follows: NaCl<sub>0</sub> – control (basic nutrient solution without added NaCl), NaCl<sub>35</sub> (control + 35 mM NaCl), NaCl<sub>50</sub> (control + 50 mM NaCl), NaCl<sub>65</sub> (control + 65 mM NaCl).

Increasing root zone salinity significantly enhanced Na and Cl accumulation in faba bean leaves. A decrease in Mo and K leaf content occurred most significantly at NaCl<sub>50</sub> treatment, as well as an increase in Mn leaf content. NaCl treatments reduced P leaf content in regard to control but without significant difference amongst treatments.

Results have shown that increased root zone salinity can affect certain faba bean leaf element accumulation, although trace element leaf content was not significantly altered. Hence, faba bean could be considered as rather salt tolerant horticultural crop.

## ASSESSING PLANTS FOR PHYTOREMEDIATION OF ARSENIC-CONTAMINATED WATER

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Phytoremediation is an innovative technology that uses plants in order to remediate polluted water and soil. A 10 week study in flowerpots was performed in order to determine the arsenic (As) removal potential of *Shoenoplectus americanus* (*Juncos*), *Eleocharis macrostachya* (Spikerush pálida) and *Baccharis salicifolia* (Chilca) and to evaluate their tolerance to increasing doses of As. The experiment used five different treatments with distinct As concentrations (1, 2, 3, 4 and 5 mg/L) and a control (faucet water) to determine the acclimatization capacity of the species to the different concentrations. The number of individuals and their height were determined during the experiment. The values for the factors of translocation, accumulation and enrichment were obtained at the end of the experiment; the maximum values for these factors were, respectively, 1.86, 92.13 and 1.63 for *E. macrostachya*, 1.73, 59.74 and 0.56 for *S. americanus* and 8.96, 27.94 and 6.72 for *B. salicifolia*. The maximum growth value belonged to the *S. americanus*. The maximum concentration of As in water tolerated by *E. macrostachya* and *B. salicifolia* was 2 mg/L. *S. americanus* showed the highest As accumulation capacity and the greatest tolerance in all of the tested concentrations. *B. salicifolia* and *E. macrostachya* proved to be translocator plants and *S. americanus* was confirmed to be a stabilizer plant with a high potential for phytostabilization and rhizofiltration techniques.

**Key words:** Phytoremediation, hydroponic system, traslocation factor, arsenic.

## CONCENTRATION OF CADMIUM IN VEGETABLES GROWN ON CONTAMINATED GARDENS AND IN PURCHASED VEGETABLES

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Self-supply with home-produced vegetables is very common in urban areas, where cadmium is a characteristic pollutant due to its anthropogenic origin. It has a harmful effect on human health. People are exposed to cadmium in different ways. One of the most common is through consumption of contaminated food, such as home-produced vegetables. However, different vegetables accumulate cadmium in different concentrations and as such pose different risk to human health. In this research 6 species of vegetables were sampled: endive, chicory, courgettes, tomato, onion and carrot. Vegetables (edible parts) were sampled in gardens of the Municipality of Celje, which is the third largest city in Slovenia. In some areas soils in the city and its vicinity are polluted with heavy metals (e.g. cadmium, lead, zinc) due to past industrial activities. Sampling area was stratified into 6 zones according to Slovenian legislation and the level of soil pollution with cadmium (mg/kg DW): <0.99, 1.00 - 1.99; 2.00 – 3.99; 4 – 7.99; 8 – 11.99; >12. Additionally, vegetables were purchased in local shops, markets and supermarkets in order to compare concentrations of cadmium in vegetables grown in gardens and in purchased vegetables. The main goal of this research was to determine whether purchased vegetables contain significantly lower concentration of cadmium than vegetables produced on gardens of the Municipality of Celje. Results showed that the significant difference between the average concentrations of cadmium in purchased and garden vegetables was observed in vegetables produced in gardens with soil cadmium content above 2 mg/kg DW. Therefore, the recommendation of rather to purchase vegetable than to produce it at home garden is justified in areas where the contamination of soil with cadmium is whether above 2 mg/kg DW, when producing carrot, chicory and endive or above 4 mg/kg DW, when producing courgettes, tomato and onion.

# DETERMINATION OF HEAVY METALS CONCENTRATIONS AND COMPARING BITTER WORMWOOD (*ARTEMISIA ABSINTHIUM* L.) MEDICINAL PLANT RAW MATERIAL COLLECTED FROM DIFFERENT LOCATIONS IN LITHUANIA

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Identify heavy metals (cadmium Cd, lead Pb, copper Cu and zinc Zn) concentrations in bitter wormwood (*Artemisia absinthium* L.) a medicinal herb, which was collected from some regions of Lithuania and was bought in pharmacy store. Compare these heavy metals averages between individual regions and plant material from pharmacy store.

Samples were mineralized using the appropriate quantities (HCl, HNO<sub>3</sub> and H<sub>2</sub>O<sub>2</sub>) reagents with (Multiwave 3000) mineralizer. Heavy metals (Pb, Cd, Cu, Zn) concentrations were identified with Perkin-Elmer 3030 atomic absorption spectrophotometer with Zeeman correction. The average concentration from samples of different regions was calculated and compared.

The results of medicinal herb (*Artemisia absinthium* L.) showed that the highest Cd concentration was purchased in a pharmacy package (1.16±0.15), which was statistically significant as compared with all other samples tested averages from other areas. Average Pb concentrations were higher and statistically significant from Vilkauskis region and the pharmacy purchased package, as compared to Ukmerge and Svencionys areas. In contrast, Zn and Cu concentrations were the lowest averages from a pharmacy package and it was statistically significant as compared to other established averages from Ukmerge, Svencionys and Vilkauskis areas.

It can be concluded that (i) the highest cadmium, lead, copper and low zinc concentrations were found of bitter wormwood plant raw material purchased from a pharmacy package, and (ii) the medicinal herb raw materials collected in Vilkauskis area stood higher concentration of Pb (1.74 ± 0.72) as compared with those originated from Ukmerge and Svencionys areas, and the difference was statistically significant.

## ASSESSMENT OF ARSENIC IN RICE, BRAN: ROLE OF ARSENIC LEVEL IN THE SOIL OF BANGLADESH

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Arsenic (As) exposure in the human body through rice has been highlighted recently due to its carcinogenic impact during long term consumption. It has been recognized that shallow tube well based irrigation practices and anaerobic cultivation influence the elevation of arsenic in the rice fields. The aim of this study to assess the accumulation of arsenic in the various rice cultivars and analysis of As exposure risk through rice in Matlab, one of the prominent arsenic hotspots in southeastern Bangladesh. Our study has found that total As concentration in the collected rice grain (1.37-2.97 mg/kg As) exceeded the global 'normal' [1] range (0.08-0.20 mg/kg As). Meanwhile, rice bran (2.80-6.52 mg/kg As) used as animal fodder showed As concentration more than 2 folds higher compared to the grain. The paddy soil (8.9-13.26 mg/kg As) with low pH (5.2-6.9), would promote higher mobility [2] of dissolved arsenic. The result indicates that, the bran contained the major part of accumulated arsenic compared to the grain. To address the reduce bioavailability of arsenic issue in the rice; further studies should be focused on the bran part of the grain.

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## EVALUATION OF RISK ASSESSMENT OF ARSENIC EXPOSURE FROM RICE AND VEGETABLES IN WEST BENGAL, INDIA

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Arsenic (As) poisoning to human body through consumption of drinking water and staple diet has become the most highlighted environmental disaster throughout the world. Currently, rice is considered as an important pathway of As exposure particularly where people are drinking As safe water. The risk of As exposure through consumption of rice and vegetables has been assessed in this study. Based on the length (L) and length to breadth (L/B) ratio, four type of rice has been classified: short bold (SB), medium slender (SL), long slender (LS) and extra-long slender (ELS). Average As concentrations decrease with increasing grain size with highest in SB ( $0.33 \text{ mg kg}^{-1}$ ) followed by MS ( $0.16 \text{ mg kg}^{-1}$ ); LS ( $0.10 \text{ mg kg}^{-1}$ ) and ELS ( $0.04 \text{ mg kg}^{-1}$ ). Vegetables which are commonly consumed by the rural people are also classified into three categories based on their edible parts such as leafy, non-leafy and root type. Highest amount of As is present in leafy vegetables ( $0.21 \text{ mg kg}^{-1}$ ), while non-leafy and root vegetables contain  $0.07 \text{ mg kg}^{-1}$  and  $0.1 \text{ mg kg}^{-1}$  of As respectively. On average, in rice 92% of total As is present in inorganic form, while in vegetables As entirely presents as inorganic species. Rice of SB type is consumed most because of its relatively low cost. About 29% of the SB consumers have total daily intake of inorganic As (TDI-iAs) higher than previous WHO recommended provisional tolerable daily intake value (PTDI) of  $2.1 \mu\text{g day}^{-1} \text{ kg}^{-1} \text{ bw}$ . Consumption of vegetable along with rice increases the TDI-iAs, although vegetables independently do not cause any significant health risk to the population. This study suggests that mitigation of As exposure among the population of rural Bengal should consider all the possible exposure pathways through food chain, in addition to drinking water.

## HOW TO SURVIVE EARLY TOXIC COPPER EXCESS?- BIOCHEMICAL AND ANATOMICAL CHANGES DURING GERMINATION OF INDIAN MUSTARD

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It is well-known that essential heavy metals like copper (Cu), mainly at higher levels, usually cause overproduction of reactive oxygen species (ROS) resulting in oxidative stress in plants. Up to now many experiments were carried out to evaluate how Cu toxicity influences in adult plants but only a few data are available about the effects during germination, since this is a very sensitive period and the effects of heavy metal stress are more expressed.

The aims of our study were to investigate potential oxidative stress and antioxidative defence mechanisms beside potential morphological and/or anatomical alterations in germinating seeds of Indian mustard (*Brassica juncea L.*) exposed to excess Cu.

The following parameters were evaluated to describe oxidative stress: FRAP (ferric reducing ability of plasma), lipid peroxidation (LP), reduced glutathione content (GSH), total protein content and the activity of glutathione-S-transferase (GST), superoxide dismutase (SOD), catalase (CAT), guaiacol peroxidase (GPOX) and glutathione reductase (GR). We also assessed histochemically LP and the loss of plasma membrane integrity in the root tips, the production of callose and the lignification of cell walls.

Our results showed that Cu treatments were followed by notable GSH-depletion. We could detect LP histochemically in the root tips. The application of Cu increased the activity of SOD in time and dose-dependent manner. The activity of CAT and GPOX increased after 48-96 h Cu excess. Morphological symptoms of metal toxicity occurred such as stunted, hooked-formed and brownish root tips. Production of callose and lignification of cell walls could be visualized, too.

## UNIQUE METABOLISM OF SELENIUM IN HEDGEHOG MUSHROOM (*HERICIUM ERINACEUS*)

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Though both yeasts and *Agaricomycetes* belong to the kingdom of fungi, their metabolic pathways are different. They can both accumulate selenium, but while yeasts convert it to organic forms up to 2000 µg/g, *Agaricus bisporus*, the most widely researched species of *Agaricomycetes* stores the excess of selenium in inorganic forms. A sample of *Hericium erinaceus*, which belongs to the same class, has been examined in our study after moderate Se-enrichment.

After enzymatic digestion and ion-pairing chromatography clean-up nearly 50% of the selenium content was found in organic form, selenomethionine. This suggested a metabolism more similar to yeasts than *Agaricomycetes*. To confirm this, an aqueous extraction and SEC fraction collection was executed on the sample in search for seleno-adenosyl compounds, typical for yeast metabolism. The primary molecule of interest was seleno-adenosyl-selenohomocysteine, one of the most abundant Se-metabolites of yeast. After multi-dimensional chromatographic purification monitored by ICP-MS and HPLC-ESI-QTOFMS based analysis three Se-adenosyl-compounds were identified, including Se-methyl-5-selenoadenosine, also taking part in yeast metabolic pathways.

This observation definitely opens a new group of higher mushrooms that can be directly exploited as raw materials for functional food purposes competing yeast-derived dietary supplements.

## QUADRUPLE IMMUNE RESPONSE OF PLANTS TO PATHOGENS AFTER PRETREATMENT WITH DIFFERENT DOSES OF TRACE ELEMENTS

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The enzymatic and/or non-enzymatic methylation/hydroxymethylation of main trace elements means a special, indispensable contact between biological (organic) and inorganic world. These modified trace elements are potential formaldehyde (HCHO) generators and HCHO formed from them can participate in different characteristic interactions. Among these interactions double effect may be the basis of diverse/controversial effects of trace elements and their multiple effects as well [1]. On the basis of up-to-date biochemical results with HCHO it is supposed that trace elements as HCHO carriers transport HCHO molecules in dose-dependent level to different points of a given biological unit [2].

On the basis of experiences with the time- and dose-dependent double immune response of plants to pathogens, a logical step was to extend it to the total Avogadro number range (in vivo conditions) in the case of trace elements as inducers as well. These new findings support that HCHO and its reaction products (mainly O<sub>3</sub>) as drastic molecules are responsible for the immunostimulating activity of trace elements as inducers. It is especially important that there are always four bioequivalent immunostimulating activity ranges in plants for the pretreatment with different doses of trace elements similar to organic compounds [3]. It has to note that the trace elements as inducers don't participate directly in the induction of the immunostimulating effect similar to organic inducers.

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## EFFECT OF MICROELEMENTS ON ALFALFA ON A SANDY SOIL

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The effect of 0, 30, 90 and 270 kg·ha<sup>-1</sup> rates of microelements on alfalfa was examined on a calcareous sandy soil in 2004 - 2008 in Órbottyán, Hungary. The salts of the microelements were applied on a single occasion at the start of the experiment in spring 1995 in the form of Cr<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub>, K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, CuSO<sub>4</sub>, Pb(NO<sub>3</sub>)<sub>2</sub>, Na<sub>2</sub>SeO<sub>3</sub> and ZnSO<sub>4</sub>. The 24 treatments (6 elements×4 application rates) in 3 replications gave a total of 72 plots. The location was prone to drought and was poorly supplied with NPK macronutrients. The ploughed layer contained 0.7–1.0% humus and 2–3% CaCO<sub>3</sub>, and the groundwater was located at a depth of 5–10 m. The whole experiment was given 100 kg·ha<sup>-1</sup> each of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O active ingredients as basal fertilizer each year.

The favourable precipitation contributed to the advantageous development and yield of alfalfa during the 5 years period. Pb and Cu loads remained in the ploughed layer. The 0.2-0.4 mg·kg<sup>-1</sup> Pb-content of the control alfalfa hay increased to 0.5-1.4 mg·kg<sup>-1</sup> on the treated soil on average. Cu concentration rose from 5-7 mg·kg<sup>-1</sup> to 9-10 mg·kg<sup>-1</sup> due to the maximal Cu load. Se showed an extreme 3-fold accumulation in hay, i.e. from under 1 mg·kg<sup>-1</sup> detection limit to 200-400 mg·kg<sup>-1</sup>. The hay became unsuitable for feeding. However alfalfa can be utilized in phytoremediation. During the 5 years the total yield of 45.5 t·ha<sup>-1</sup> alfalfa hay contained 6-12 kg·ha<sup>-1</sup> Se. In 2006 after the 12<sup>th</sup> year of the experiment the leaching zone of Cr(VI) exceeded 3 meters, and that of Se exceeded 4 meters in 270 kg·ha<sup>-1</sup> treatments. Vertical movement could not be verified in the case of Cr(III), Pb, Zn, Cu.

## **DEPOSITION OF ORGANIC TRACE METAL COMPLEXES AS FEED ADDITIVES IN FARM ANIMALS**

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Trace elements are essentials for maintenance and production of farm animals, but most of the feedingstuffs do not contain adequate amount of most of them, therefore supplementation of complete feeds with trace elements is necessary. However, the rate of absorption and tissue deposition of trace elements from different complexes is also different which may have food safety aspects because of the maximum level of some trace minerals.

The present review, based on scientifically proved data, discuss about the rate of deposition of different metal (Cu,Zn,Fe and Mn) proteinates, some amino acid chelates (e.g methyl-hydroxy-methionine) of trace elements (Mn and Zn), and also about the rate of absorption of some metal-propionates and humic acid complexes.

The results showed that metal proteinates have higher rate of tissue accumulation as compared to inorganic salts, and additionally some metal-proteinates (e.g. copper-proteinate) also improves the tissue deposition of manganese. Metal propionates, as possible new trace element supplements have positive effects on the rate of absorption which was proved by the higher blood serum levels. In the case of humic acid chelates there are some data about their positive effect on bioavailability of trace minerals but those were not scientifically proven.

In conclusion it can be stated that organic metal complexes have better bioavailability than their inorganic counterparts, in particular modern farm animal genotypes with higher requirement level and also in stress conditions.

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## **EFFECT OF COBALT-EDTA ON IRON CONTENT IN SPLEEN AND LIVER OF IMMATURE MICE**

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Cobalt (Co) is an essential trace element and its accumulation affects the concentrations of other elements [3]. Co(II) is shown to compete with iron (Fe) for the transferrin receptor and to form a stable complex with hemoglobin [2] thus affecting hematopoiesis. There is a lack of data regarding the effect of chronic exposure to Co compounds and Fe content in spleen and liver of mice. The study investigates the effect of long-term treatment with cobalt-EDTA (Co-EDTA) on iron content in the spleen and liver of immature mice. Pregnant ICR mice were subjected to chronic treatment with a daily dose of 75 mg/kg Co-EDTA until d25 of the newborn pups. Results show accumulation of Co(II) in the organs of treated mice compared to age-matched controls. Fe content was affected as well. Increased concentrations of Fe ions were measured in the livers of treated mice. The observed changes may explain the impaired hematopoiesis in the spleen of immature mice [1] exposed to Co(II).

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## THE FATE OF NANOSELENIUM IN THE SOIL-PLANT-ANIMAL SYSTEM

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Selenium is a well-known essential trace element, but the inorganic forms like selenites and selenates can be overdosed easily. Elemental selenium is considered as the least toxic selenium of all forms and in the same time supplementation with its nano-size particles has the same or better bioavailability compared to salts. We developed a fermentation technology for production of nano-size (100-500 nm) red elemental selenium by using probiotic yogurt bacteria.

We treated chernozem and sand soils with nanoselenium and after 8 weeks of treatment the total and acid soluble selenium content of the soils was measured. The effects of nanoselenium on callus initiation and plant regeneration was tested using tobacco plants. In our experiment with quail and chicken, we examined the effect of selenium on the number and size of the eggs, and the antioxidant capacity in the blood. We analyzed the selenium content of feather, muscle, liver and eggs of broiler and layer chicken in order to produce selenium-enriched eggs. We produced selenium-enriched lamb meat to use as functional food, and tested its effect on rats. We compared the toxicity and bioavailability of the different selenium forms in an experiment with mice.

We concluded: nanoselenium is an effective, highly bioavailable, nontoxic form of selenium that in soils behaves like a long-lasting selenium reservoir, providing a constant, ideal level of selenite, satisfying the selenium needs of plants, and can be used as food or feed supplement. In the presentation we present the possible explanations of the obtained results.



# ADVANTAGES AND DISADVANTAGES OF ARSENAZO III AND CHLOROPHOSPONAZO III UTILIZATION FOR SPECTROPHOTOMETRIC Th DETERMINATION

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The paper is devoted to the evaluation of important validation descriptors concerning the spectrophotometric determination of thorium using Arsenazo III and Chlorophosponazo III. In diluted hydrochloric acid the complex between Th and Arsenazo III is formed instantly and remains stable for 25 minutes with constant absorbance. Beer's law is obeyed in the range from 0.70 to 11.64  $\mu\text{mol} \cdot \text{L}^{-1}$ . The molar absorptivity at 660 nm is equal to  $9.74(\pm 0.09) \cdot 10^4 \text{ cm}^{-1} \cdot \text{mol}^{-1} \cdot \text{L}$  (data in parentheses stands for standard deviation). The relevant relative standard deviations (RSD) reached  $\pm 1.48\%$ ,  $\pm 4.34\%$  and  $\pm 3.07\%$ , respectively.

Thorium concentration can be quantified using Chlorophosponazo III in media of diluted nitric acid. The linear range of the proposed method was from 1.59 to 18.10  $\mu\text{mol} \cdot \text{L}^{-1}$  of thorium. The experimentally determined values of molar absorptivity reached  $\varepsilon_{691} = 3.76(\pm 0.05) \cdot 10^4 \text{ cm}^{-1} \cdot \text{mol}^{-1} \cdot \text{L}$ . The repeatability and trueness of determination in the linear range did not exceed  $\pm 2.2\%$  and  $3.3\%$ , respectively. Colour stability of the Th-Chlorophosponazo III complex maintained a constant value for at least two hours. LOD and LOQ values for both methods were established applying three approaches – the 3- $\sigma$ , the ULA2 and the Hubaux-Vos ones.

## **METHODOLOGICAL DEVELOPMENT IN THE DETERMINING OF COPPER CONTENT IN THE ROOT ZONE OF HUNGARIAN SOIL TYPES – PRELIMINARY RESULTS**

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Heavy metals have been used since ancient times in the history of humanity. People started to use copper, gold and silver during the Copper Age in Europe, between 3500-2500 B.C.

The human body contains about 80 mg copper, which can be found mostly in eyes, brain, liver, heart, kidneys and musculature. Copper is less mobile in soil, it occurs bounded with carbonates, sulphates, organic compounds and clay. The copper content of uncontaminated soil is 1-140 mg/kg in global average. This strongly depends on the soil's clay fraction content.

In our research we studied the adsorption capacity of copper in eight soil samples (made from four different soil types: brown forest soil, chernozem, meadow soil and sand with humus), in five different concentrations. The soil samples came from Tiszavasvári, Dunaújváros, Gödöllő and Budapest-Soroksár, Hungary. The concentrations were 1, 5, 10, 25, 50 g/dm<sup>3</sup> aqueous solution of CuSO<sub>4</sub>. In our method we made soil columns, in which we put 50 g prepared soil samples and poured on copper solutions in known concentrations. The concentrations of runoff filtrates were determined by titration. From the two different concentration values we calculated the soil samples' adsorption capacity.

Data were statistically analyzed with IBM SPSS Statistics 20.0 software by two-way analysis of variance (ANOVA). Our results showed that the copper adsorption of soil is significantly different at different level of concentration of contamination ( $p < 0,05$ ). However, the difference is insignificant in case of the four soil types ( $p < 0,05$ ).

## ANALYSIS OF *FICUS CARICA* L. – VOLATILE COMPONENTS AND MINERAL CONTENT

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*Ficus carica* L. is a well-known Mediterranean plant, its fructus - the fig- is consumed widely, mostly in the south region of Europe. Many investigations are carried out to determine the active components of plants of traditional medicine and nutrition.

One part of our research was to determine the volatile components of *Ficus carica* L. Beside the traditional extraction methods (solvent extraction and steam distillation) solid phase micro extraction connected to GC-MS was also used. The main component of the volatile substances in fruit is: 2,3-butane-diol. In the fruit 11 components were detected. Beyond the classic volatile components (limonene, benzaldehyde), saturated and unsaturated aliphatic compounds were found, as well alicyclic components like: ethyl-cyclohexanol, dimethyl-ciclohexanol, 6-methyl-5-heptene-2-on, oktadiene-2-on, undekane, dimethyl-undekane and trimetyl-biciclononane and hexanal.

The microscopic features of samples were also examined. Several Ca-oxalate rosettas and covering trichomes on the folium were found. In the fructus oil drops and oil beads were present with several covering trichomes and Ca-oxalate rosettas.

Macro- and micro elements were determined by ICP method. The fig fruit and folium from Hungarian trade were examined and compared with Italian origin plant folium. We found that the folium of Italian origin contained higher B, Ca, Cr, Cu, K, Na, Sr concentration, than the folium of Hungarian origin. The amount of Fe was higher in both folium samples compared to the fructus. Boron, Ca, K, Mg and P elements were in larger quantities in the fructus sample.

## NON-USUAL WAY OF SELENIUM-METABOLOMICS: SEARCHING FOR THE INFLUENCED PATHWAYS

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Usual seleno-metabolomics is achieved through multidimensional chromatographic clean-up procedure monitored by ICP-MS and ESI-MS based identification after a demanding search for selenium patterns in molecular mass spectra. Even if this procedure is assisted by retention time matching from parallel chromatographic systems, this approach is labor demanding and indicates nothing about any other compounds influenced by the Se enrichment. Therefore, detection of other than Se species should give a hint on the influence of the enrichment process on the metabolome of the given organism.

In the recent work the Se-metabolism related compounds were searched and detected in moderately Se enriched hedgehog mushrooms (*Hericium erinaceus*). The hypothesis was that the Se uptake also changes non Se-related metabolic pathways and we focused on Se-free compounds. The goal was to detect and identify the most related compounds by LC-MS after a metabolomic software assisted differentiation process between treated and untreated mushroom samples. In the case of moderate enrichment Se does not induces stress but must start or enhance new way of metabolic pathways which results in decreased/increased abundance of the unknown target analytes. In our study we present that different levels of Se enrichment are required to be able to assign molecules that can be related to theoretically independent biochemical pathways.

**ELECTRON PARAMAGNETIC RESONANCE SPECTROSCOPY TO  
DETERMINE STRUCTURAL AND SOLUTION EQUILIBRIUM DATA;  
COMPLEXATION OF SALICYLALDEHYDE SEMICARBAZONE WITH  
Cu(II) AND VO(IV)**

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Electron Paramagnetic Resonance (EPR) spectroscopy is able to determine the electronic and local geometric structure of paramagnetic species. Since many of the metal ions among microelements are paramagnetic (Fe(III), VO(IV), Cu(II), Mn(II), Co(II), etc.), this technique can be used for studying paramagnetic metal ions in the research fields of trace elements. In this work, the use of EPR spectroscopy is presented by the help of a complexation properties study of Cu(II) ( $S=1/2$ ,  $I=3/2$ ) and VO(IV) ( $S=1/2$ ,  $I=7/2$ ) towards salicylaldehyde semicarbazone (SSC), in solution mixture of 30 w/w % DMSO/H<sub>2</sub>O. pH-potentiometry and UV-Vis spectroscopy were used in order to determine the constitution and formation constants of the species evolved in the solution. To deduce spectroscopic parameters, offering information about the nature of coordinating groups, a series of pH-dependent EPR spectra were recorded at room temperature by the help of an in situ titration. The simultaneous analysis of this spectrum series provided the formation constants and spectroscopic parameters of EPR-active species, at the same time. Furthermore, at different pH's some sample were measured under liquid nitrogen (at 77 K) to determine the anisotropic EPR parameters which offer more detailed information about the structure of the complexes. In Cu(II) – SSC system  $[CuL]^+$  and  $[CuLH_1]$  complexes have been identified and for VO(IV) – SSC system  $[VOL]^+$ ,  $[VOLH_1]$  and  $[VOLH_2]^-$  have been detected, beside the aqua complexes.

## HEAVY METAL DISTRIBUTION OF FLOODPLAIN SOILS AND PASTURES OF THE TISZA RIVER

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The Hungarian section of the Tisza River is highly influenced by metal pollution sourced from mining activity in Romania. Mining in Maramures County (former Máramaros) traditionally exploits host ores of base metals (Cu, Zn and Pb) and precious metals (Au and Ag). Nowadays the processing of old tailings pond material by using cyanide to recover Ag and Au is spread in this region. Mining activities that use dangerous and toxic chemicals such as cyanide can be serious sources of contamination. The aim of this study was to evaluate the long term effects of pollution events. Easily available metal contents of samples collected in 2011 from floodplains and pastures along the Tisza (Tivadar, Vásárosnamény, Rakamaz, Tiszacsege) were investigated and compared to our earlier results (Győri et al., 2003). Cu and Zn contents were measured by Optima 3300 DV ICP-OES (Perkin-Elmer). The measurement of Pb and Cd was conducted by QZ 939 GF-AAS (Unicam) in 2000 and by an X7 ICP-MS (Thermo Fisher) in 2011.

We found that during a 11 year period the easily available Cd, Cu, Zn and Pb contents of the floodplain soils increased. This may be caused by the periodical flood events and the mobilization of the pollutants. Furthermore, high available Zn and Pb contents – exceeding the limit value of available metal content – were observable in the studied soils.

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## MINERAL CONTENT OF HERB VARIETIES ON A FLOODPLAIN PASTURE BY THE TISZA RIVER

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In order to produce good quality products it is necessary to find out about the quality of pastures to be grazed. It is also important to know the element composition of grazed herbs and the demands of animals bred on pastures, especially where the environment may influence the feed safety conditions of plants – as in the case of floodplains. Our objective was to determine that what the element composition (Cu, Zn, Mn and Fe contents) of herbs grown on a floodplain which was subsided by a heavy metal contaminated sediment. Our results call attention to the differences in the accumulation of herbs. *Bidens tripartitus*, *Lotus corniculatus* and *Vicia cracca* grown in the floodplain showed the higher amounts of Fe and Zn, but the effect of heavy metal contamination on the element contents of other examined plants cannot be proved.

## **CHEMICAL WATER QUALITY CHANGES ALONG A STREAM AT AN ABANDONED PB-ZN MINING SITE**

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In this study, chemical water quality changes downstream a pool-riffle type stream located at a former Pb-Zn mining site are discussed. The watershed of the Toka stream (Mátra mountain, Hungary) being under rehabilitation is still continuously affected by a neutralised acidic mine drainage, and temporarily, by an abandoned mine tailing. Upstream the AMD confluence which gives the major part of the water flux, indeed, the stream is of high water quality, while, directly after that, the electric conductivity is app. quintupled, the dissolved oxygen concentration decreases, and the pH as well as the trace element concentrations increase, as expected. However, within 10 kilometers, Zn, Pb, Ni, Cd and As concentrations are all remarkably decreased in relation to the distance from the contamination source, and they almost reach the actual background levels. Since the electric conductivity does not show significant change along the investigated section of the stream, which would indicate the dilution, and the presence of amorphous Fe(OH)<sub>3</sub> in the sediment is obvious, based on the pH-Eh relations and geochemical analysis, the adsorption processes may have considerable role in the decrease of trace element concentrations in solution.



# **INVESTIGATION OF EFFECTS OF TWO ENVIRONMENTAL HEAVY METALS IN A COMBINED EXPOSURE MODEL ON THE NERVOUS SYSTEM IN RATS**

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Human exposure to toxic heavy metals includes inhalation of metal fumes and dusts, typically from workplace atmosphere, and ingestion with drinking water and food taken from polluted environment. In the study presented, the interaction of inhalational and oral exposure to manganese and lead was investigated. Young adult male Wistar rats (2 x 10 per group) were treated orally with MnCl<sub>2</sub> (15 and 60 mg/kg b.w.) or Pb acetate (80 and 320 mg/kg) for 3 or 6 weeks. Then, one half of the groups was further treated by intratracheal instillation of nanoparticulate MnO<sub>2</sub> (2.63 mg/kg) or PbO (2 mg/kg) for an equally long period. Body weight gain and signs of general toxicity were regularly checked. Finally, the rats' motor behaviour was tested in an open field box, and their spontaneous and evoked cortical electrical activity was recorded in urethane anaesthesia. Body weight gain was disproportionately strongly reduced by MnO<sub>2</sub> nanoparticles, but with Pb, the weight effect was more dependent on dose. In the open field test, Mn caused hypomotility, more strongly after 6 weeks oral plus 6 weeks intratracheal than after 6 weeks oral treatment. Pb-treated rats showed increased ambulation but less rearing and somewhat longer local activity. Spontaneous cortical activity was shifted to higher frequencies after oral Mn application, but this change was not intensified by subsequent nanoparticle application. Oral Pb had an opposite effect. Cortical evoked potentials showed latency lengthening. In several cases, the effect of Mn and Pb was about as strong after 3 weeks oral plus 3 weeks intratracheal as after 6 weeks oral administration, although the summed dose was ca. two times lower in the former case.

There can be a more-than-additive interaction between the amounts of heavy metals entering the organism in different routes and chemical forms.

## MAGNESIUM SUPPLEMENTATION AND MICROELEMENT HOMEOSTASIS

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Magnesium participates in numerous enzymatic reactions in the human body and it has an essential role in the maintenance of the antioxidant system. Our purpose was to investigate the effect of magnesium supplementation on the element content in blood.

Male Wistar rats were divided into four groups. The animals in group I. were fed a normal diet, the animals in group II. were fed a normal diet and treated with magnesium poligalacturonate. The animals in group III. were fed a fat rich diet containing cholesterol (2.0 %), sunflower oil (20%) and cholic acid (0.5 %) added to the control diet. The animals of group IV. were fed a fat rich diet and magnesium poligalacturonate (200 mg Mg/kg body weight ad libitum daily). The rats were kept on these diets for 9 days.

Element concentration (Al, As, B, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Ni, P, Pb, S, Si, Sn, Sr, Ti, V, Zn) of blood samples was determined with an ICP-OES after digestion with a mixture of nitric acid and hydrogen peroxide (10+5 ml).

The results show that the concentration of several elements changed significantly in both magnesium-treated groups, however, the alteration was different in the control and hyperlipidemic group. It can be concluded that high amounts of magnesium supplementation change the metal ion homeostasis even in a short term experiment. Although some favorable effects were observed in the hyperlipidemic group after magnesium-treatment, it is worth noting that magnesium supplementation should be administered very carefully, especially in metabolic diseases.

## CHANGES IN METAL HOMEOSTASIS IN EXPERIMENTALLY INDUCED FATTY LIVER BY THE EFFECT OF SOUR CHERRY CONSUMPTION

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Sour cherry (*Prunus cerasus*) is a favored fruit worldwide. Sporadic studies occurred to determine the metal ion content of fruit. Nevertheless its effect on metal ion homeostasis has not been examined so far, therefore, animal experiment was carried out to determine the changes of metal homeostasis in liver by the effect of sour cherry.

Wistar rats were divided into four groups: 1. control animal with normal diet; 2. hyperlipidemic rats fed with fat rich diet (chow contained plus 1% cholesterol, 0.3% cholic acid and 11% sunflower oil); 3. rats fed with normal diet+lyophilized sour cherry (0.75g/kg body weight daily); 4. rats fed with fat rich diet and lyophilized sour cherry. Three types of sour cherry (Pipacs, Fanal, Újfehértói fürtös) were supplemented for 10 days.

From the rat liver homogenate (protein content: 1%) metal ion content was determined by ICP-OES after digestion with 67% HNO<sub>3</sub> and 30% H<sub>2</sub>O<sub>2</sub>. For histological study liver fragments were fixed in 4% neutral buffered formalin, embedded in paraffin, and 5 µm sections were cut and stained with hematoxylin–eosin.

As a result of our experiment the concentration of metal elements were found to decrease significantly in the hyperlipidemic animals fed with sour cherry, although there wasn't any significant result between the 1. and the 3. group. On the basis of histological study it was established that the treatment with Fanal was the best, although Pipacs and Újfehértói fürtös were also significant in liver regression of hyperlipidemic animals with fatty liver, therefore in conclusion sour cherry treatment is beneficial.

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## **EATING HABITS OF TUMOROUS PATIENTS - IN RELATION TO THEIR TRACE ELEMENT STATUS**

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The relationship between eating habits and malignant diseases is one of the most researched questions of healthy nutrition. Foods and its ingredients can make a protective and permissive influence on tumorous diseases. In this questionnaire, we emphasised fruits and vegetables which can play an important role in healthy nutrition. (Licence Nr. TUKEB 153/2000). We asked 74 tumorous patients (26 female, 48 male, mean age was 61 years). 78% have colorectal cancer, 18% breast cancer and 4% hepatocellular cancer. 77% of patients eat fruits every day, 85% of patients consume vegetables with the same frequency. The most popular fruits are peach, apple, strawberry and raspberry, much loved vegetables are potato, pepper, tomato, green beans and peas. Comparing tumorous and healthy people, grape and sour cherry are much more popular fruits among tumorous patients, but dates, pistachios, grapefruit and figs are less popular among tumorous patients than among healthy people. Examining vegetable consumption, we found that beetroot, cabbages, kohlrabi and pumpkin are much more liked by tumorous patients than by healthy subjects. Aubergine and pattypan squash are poorly liked among tumorous patients. 23% of patients drink milk every day, 38% never drink milk, but may eat dairy products. According to literature data, 35-45% of tumorous diseases are caused by unhealthy nutrition. This survey is focused on the current eating habits of patients. Many people started eating much more health-consciously since their diagnosis, but – partly caused by the therapy – they either don't wish or can't consume certain foods, furthermore their absorptions are also disturbed so there may be differences of trace element intake between the healthy and the tumorous states.

## METAL HOMEOSTASIS IN PATIENTS AFTER COLECTOMY

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Metal ions play an important role in the body's cellular energy homeostasis, proliferation and apoptosis. According to monographs in cancerous states, this balance is broken and it remains so even after removing the malignant tissue.

The concentration of Cu, Mn, Zn, Se, Fe, P, S, Ca, Mg, Al elements were determined by ICP-OES in red blood cells of 29 female and 18 male healthy volunteers, furthermore of 19 female and 19 male patients who underwent surgical intervention (age range 45-83 years). In the colectomised patients, tumor marker levels remained within normal range.

Comparing the male and female control groups, copper (Cu) concentrations differed significantly ( $p < 0.05$ ). In colectomised patients, the only notable difference between men and women was the average selenium (Se) level (males:  $7.96 \pm 10.32$  ng/g vs. females:  $18.26 \pm 7.11$  ng/g). Comparing both genders of the control and colectomised groups, the Se levels of females decreased, while Se levels in males increased. Between male groups, Fe, P, S and Se levels showed significant differences ( $p < 0.05$ ), while between female groups, a relevant difference was found for zinc (Zn) (control:  $0.399 \pm 0.126$   $\mu\text{g/g}$  vs. tumorous:  $0.561 \pm 0.274$   $\mu\text{g/g}$ ), P and Al.

Conclusion: when rehabilitating female patients, Se substitution should be taken into consideration. The antagonism between Se and Zn is well reported in the literature. Probably the higher Zn concentration in erythrocytes of female patients compared to males has a compensatory scavenger effect by the activity of the Zn metallothionein enzyme.

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## **CLINICAL ACTIVITY SCORES ARE IMPROVING IN PATIENTS WITH MILD GRAVES' ORBITOPATHY RECEIVING ADJUVANT SELENIUM SUPPLEMENTATION**

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The essential trace element selenium (Se) exerts complex effects on the endocrine and immune systems, partly due to its antioxidant capacity. The importance of an optimal Se intake has been established in autoimmune thyroiditis. A recently published study reported beneficial results in Se supplemented patients with mild Graves' orbitopathy.

Eight female patients with mild Graves' orbitopathy and three female patients with mild orbitopathy based on Hashimoto thyroiditis participated in the study (age range: 31-79 years). The status of the orbita was registered at the beginning of the study and one-six months thereafter both according to the ATA and clinical activity scores (CAS). The following clinical parameters were determined at each visit: TSH, fT<sub>4</sub>, fT<sub>3</sub>, antibodies against the TSH-receptor, anti-TPO and anti-TG levels. The patients were treated according to their thyroid hormone status, their antibody results and their CAS. Moreover, they received adjuvant Se as 100 or 200 µg selenomethionine. Serum Se concentrations were measured before Se supplementation was implemented and 1-6 months after the beginning of treatment.

ATA scores improved in 10 patients and worsened slightly in one female patient. CAS improved in all study participants. Mean Se concentrations were 75.08±11.55µg/l before supplementation was started and 84.21±6.76µg/l one-six months later (p<0.05). At the beginning of the study, 7 and 9 patients had elevated anti-TPO and anti-TG values, respectively. After Se supplementation, both anti-TPO and anti-TG levels decreased or reached the normal range (except in the case of one patient).

This is the first Hungarian study administering adjuvant Se supplementation of patients with mild Graves' orbitopathy. Based on our results, patients currently enrolled in the study will continue Se supplementation for another 6 months.

## **DIFFERENCES IN ALUMINIUM CONTENT OF VARIOUS TEA POWDERS (BLACK, GREEN, HERBAL, FRUIT)**

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Trace elements play a big role in human health. Some trace elements are essential, some are even harmful – especially in higher concentrations. Aluminum is not considered as essential element for men, but has, in contrary, been correlated with various human pathologies as for example dementia, Parkinson and Alzheimer disease. Its uptake is mainly via food and drinking water, where it occurs naturally or in form of a food additive or via contact with Aluminum containing devices used during food preparation and storage. The permissible daily dose for an adult is given with 60 mg of Aluminum. Although no limit concentration for Aluminum is given in the Codex Alimentarius Austriacus, the determination of the Aluminum content in food and beverages is of concern.

In this investigation, different kinds of tea (black tea, green tea, fruit tea and herbal tea) were analyzed for their content of magnesium. The powders were brought into solution with a microwave assisted digestion with diluted nitric acid. The Aluminum content has been determined with ICP-OES (inductively coupled plasma-optical emission spectroscopy).

Statistically significant differences between the different kinds of tea could be found, whereby the real tea types (green and black) tea contain more Aluminum than fruit or herbal teas.

## **COMPARISON OF MAGNESIUM AMOUNT IN BLACK, GREEN, FRUIT, AND HERBAL TEAS**

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The diet is the main source of minerals and trace elements, thus exposure to dietary essential elements has a direct impact on human health. Magnesium is a major component of the bones, but furthermore it influences the nervous system and muscle activity. Therefore its needs must be met via nutrition. There is a non-negligible discrepancy between intake and requirements. So magnesium is often uptaken in form of nutrition supplements. Thus there is still an interest in the amount of magnesium in natural products, where it is supposed to vary.

In this study, various commercially available tea powders (sold in bags) of different kinds of tea (black tea, green tea, fruit tea and herbal tea) were analyzed for their content of magnesium.

After a microwave assisted digestion with nitric acid and water at temperatures up to 220°C, the element concentrations have been measured with ICP-OES (inductively coupled plasma-optical emission spectroscopy) as it is a simultaneous, fast and reliable method with low detection limits. All samples have been prepared in duplicate.

In all samples high amounts of magnesium (approx. 10 mg/g) could be found. This fact is satisfying from the nutritional point of view. No statistically significant differences were registered between the different classes of teas.



## SEDIMENT STUDIES IN HUNGARIAN WATERS

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The role of sediment and epipelon (organisms living on the surface of or in the fine-sized sediments) is significant in the life of aquatic ecosystems. The sediment is the place where the change of ion-transport occurs between the aquatic and solid phases, there are dynamic balance and bumper system between the sediment particles and the particles in the surrounding medium. As a result of the activity of the epipelon and the sediment organisms the metabolism pathways come into being in the aquatic ecological systems that can indicate or influence on the habitat characteristics. Changes in the quality or quantity of epipelon indicate changes in water quality. From the point of view of nature conservation it can characterize a natural status or indicate the degree of disturbance (degradation).

We measured the ETS (Electron Transport System)-activity of the epipelon which gives the maximal intensity of the respiration metabolism. In the analysis of the epipelon the measuring of the ETS-activity can be used of the returns of taxonomic effects such as sublethal or physiologic damage caused by toxic poisons which cannot be discovered immediately and directly by taxonomic parameters, but the smaller breath-activity can mark a changing state. ETS tests are suitable for indicating environmental stress.

## INFLUENCE OF CADMIUM AND MONENSIN ON RENAL AND CARDIAC FUNCTION OF MICE, SUBJECTED TO SUBACUTE CADMIUM INTOXICATION

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Due to its biological half life, Cadmium (Cd) has been considered a dangerous environmental pollutant. Studies in animal models have demonstrated that chronic exposure to Cd in environmentally relevant low doses causes morphological alterations in the proximal renal tubules. The correlation between renal dysfunction and Cd-induced hypertension has been discussed. In this study, we present novel results that demonstrate that Cd induced an increase of serum creatinine and glucose levels in mice, whereas the lipid profile remains unaffected. Monensin (applied as tetraethylammonium salt) improved serum creatinine and glucose values in the Cd-intoxicated mice. The chelating agent significantly reduced the Cd concentration in the kidney and heart of the Cd-treated mice and ameliorated Cd-induced alterations in the organ/body weight indices.

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## EVALUATION OF CONNECTION BETWEEN TRACE ELEMENTS AND HOMOCYSTEINE CONTENTS IN HEMODIALYSIS PATIENTS

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In animals, trace elements such as cobalt (Co) and nickel (Ni) attenuated vitamin B<sub>12</sub> deficiency-induced hyperhomocysteinaemia (HHC). HHC is associated with atherosclerosis which is one of the main causes of death in hemodialysis (HD) patients. However, the relationship between homocysteine and these trace elements has not been examined in human. Therefore, we determined the correlation between Co and Ni and homocysteine in 122 hemodialysis patients and 50 healthy controls. Since selenium (Se) plays an important role in the prevention of oxidative stress, its concentration was also determined. As the concentrations of the determined elements are low and the quantity of samples is limited, inductively coupled plasma mass spectrometry (ICP-MS) was used for measuring the concentrations of Co, Ni and Se in human serum.

When patients were divided into groups according to their homocysteine level, we found no significant differences in their Co and Se concentrations, while Ni negatively ( $r=-0.289$ ,  $p<0.006$ ) correlated with the concentration of homocysteine independently of any methylenetetrahydrofolate reductase polymorphism. Ni, but not Co at concentrations found in HD patients significantly decreased homocysteine and S-adenosylhomocysteine concentrations in human peripheral mononuclear cells. These results suggest that nickel might also be involved in the regulation of the methionine-folate cycle in humans, as was demonstrated in animal experiments.

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## AMMONIUM VANADATE REDUCES VIABILITY AND PROLIFERATION OF CULTURED VIRUS-TRANSFORMED CHICKEN HEPATOMA CELLS

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Vanadium compounds have been reported to possess anti-neoplastic potential especially against chemically-induced liver, mammary, and colon carcinogenesis in rodents. According to the literature available, the anticancer activity of vanadium compounds in virus-transformed tumor cells has not been clarified yet. The aim of the study presented was to evaluate the effect of ammonium vanadate ( $\text{NH}_4\text{VO}_3$ ) on viability and proliferation of cultured retrovirus-transformed chicken hepatoma LSCC-SF-Mc29 cells. The cells carry specific viral oncogene – v myc, and it is well known that *myc* (*c-myc*, *L-myc*, *N-myc*) proto oncogenes are involved in pathogenesis of > 80% of human malignancies. The investigations were performed by thiazolyl blue tetrazolium bromide (MTT) test, neutral red uptake cytotoxicity assay and double staining with acridine orange and propidium iodide. The results obtained revealed that applied at a concentration range of 0.1–20  $\mu\text{g/ml}$  for 24-72h  $\text{NH}_4\text{VO}_3$  expresses significant cytotoxic and/or cytostatic effects that are time- and concentration dependent.

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## ALTERATIONS IN ADULT MOUSE TESTIS AFTER SUBACUTE INTOXICATION WITH CADMIUM AND MONENSIN DETOXICATION

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Cadmium (Cd) is a heavy metal and a major environmental toxicant. The general population is exposed to Cd mainly via drinking water and food. We used a mouse experimental model to investigate the *in vivo* effects of Cd and the chelating agent Monensin on testis and sperm count in adulthood. Animals were divided into three groups: normal control (receiving distilled water and food): Cd group, exposed to 20 mg/kg b.w. Cd(II) acetate for the first 2 weeks of the experimental protocol and Cd+Monensin group, receiving Monensin (18 mg/kg) after Cd-intoxication from 15<sup>th</sup> to 28<sup>th</sup> days). Histological observations of the testis demonstrated that Cd caused desquamation of germ cell and their assemblance in the luminal region of the tubules. Areas in the testis without spermatides in latest steps of differentiation were also observed in this group. Monensin administration to Cd-treated animals restored histology of the testis to normal in great extent (despite some Sertoli-cell-only tubules). Statistically significant changes for sperm count were not established for any of the experimental groups. In addition to depleting Cd-concentrations in other investigated organs of Cd-intoxicated mice (our previous data) Monensin can reduce injury of the testis and normalize its morphology after subacute exposure to Cd. The results, presented in this study demonstrated that Monensin is a good candidate in chelating therapy of some heavy metal intoxications.

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## **EFFECTS OF $\text{CoCl}_2$ AND Co-EDTA ON TESTICULAR MORPHOLOGY AND SPERM COUNT IN MOUSE**

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Cobalt (Co) is an essential trace element for mammals essential for vitamin B<sub>12</sub> synthesis. When applied chronically cobalt tends to accumulate in different organs and tissues and this can induce pathological alterations. We focused our study on the comparative effects of chronic exposure to cobalt chloride ( $\text{CoCl}_2 \cdot 6 \text{H}_2\text{O}$ ) or cobalt EDTA (Co-EDTA) on testis and sperm count in mice at different ages. Both compounds were applied via drinking water at two daily doses - 75 mg/kg or 125 mg/kg. Treated animals were sacrificed at different time intervals (on days 18, 25, 45 and 60). On days 45 and 60 were observed the most obvious changes in testis morphology - depletion and retardations in germ cell development, disorganization of seminiferous epithelium and SCO (Sertoli-cell-only) tubules. In early puberty testis weight was reduced in similar extend (with 25%) after high doses of both Co compounds whereas in early maturity and adulthood this parameter was reduced significantly more severe after high dose  $\text{CoCl}_2$  exposure compared to Co-EDTA, probably due to the stability of the complex Co-EDTA and its weaker absorption. Concerning gonado-somatic index and sperm count in mature animals we found similar tendency of more adverse effects of high dose of  $\text{CoCl}_2$ . As a result of our work and data in literature we can conclude that the effects of chronic exposure to cobalt depend of the type of the compound used, dose, time duration as well as on the age of the experimental animals. Cobalt could be considered as a possible risk factor for male fertility and health.

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# GENERAL AND BEHAVIORAL TOXICOLOGICAL EFFECTS OF SUBCHRONIC INORGANIC ARSENIC AND FLUORIDE TREATMENT IN ADULT WISTAR RATS

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Oral exposure of humans by excess amounts of arsenic and/or fluorine may cause disturbances of the nervous system. In the present experiment, such exposure was modelled in rats, with general and behavioural endpoints being examined. Seven weeks old adult male SPF CrI:WI BR Wistar rats ( $160\pm 20$  g, 4 groups of 12 rats each) were treated with sodium (meta)arsenite (10 mg/kg b.w.; *As*), sodium-fluoride (5 mg/kg b.w.; *F*) and their combinations (*As+F*) per os by gavage, 5 days a week once a day for 6 weeks. An untreated control group was also used (*Control*). General toxicological parameters (body weight gain, food and water consumption) were measured daily. Behavioural investigations (rota-rod and open field [OF]) were done in the 4<sup>th</sup> and 6<sup>th</sup> weeks of treatment.

Weekly body weight gain was significantly reduced in the *As* (vs. *F*) and *As+F* (vs. *Control* and *F*) groups from the first week on. This difference was seen during the whole treatment period, and was more prominent from the second week (*As* and *As+F* vs. *Control* and *F*). *As*, but not *F*, affected the relative weight of the liver, spleen and kidneys. Food and water consumption in the *As* and *As+F* groups was significantly reduced (vs. *Control* and *F*). The animals' increased water consumption in *F* group was not significant vs. other groups. In the OF test, *As* and *As+F* caused significant decrease in rearing and ambulation, and increase in immobility and local activity, vs. *Control* and *F*. In the rota rod performance, no noteworthy change was observed.

In the treatment regime applied, significant effects on both general and behavioural endpoints by arsenic, but not by fluorine, were detected, which underlines the risk from environmental exposure.

## **EFFECTS OF SELENIUM AND SIMULTANEOUS EXPOSURE TO SELENIUM AND DIAZINON ON FEMORAL BONE STRUCTURE IN ADULT MALE RATS**

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The present study aimed to investigate the macroscopic and microscopic structure of femoral bone tissue in adult male rats after selenium (Se) and simultaneous exposure to Se and Diazinon (DZN). 1month-old male Wistar rats were randomly divided into three groups, each containing 10 males. In the first group (EG1), rats were administered by Se at the dose of 5 mg of Na<sub>2</sub>SeO<sub>3</sub>/l in drinking water for 90 days. In the second group (EG2), animals received a drinking water containing 5 mg of Na<sub>2</sub>SeO<sub>3</sub>/l and 40 mg of DZN/l for the same treatment period. Ten 1month-old males without Se and DZN administration served as a control group (CG). Our results revealed a significant decrease in femoral length and cortical bone thickness in experimental groups (EG1, EG2) of rats compared to the control ones (CG). Rats from experimental groups (EG1, EG2) also displayed different microstructure in the middle part of the femur, where vascular canals expanded into central area of the bone while, in control rats, these occurred near endosteal surfaces only. Additionally, a smaller number of primary and secondary osteons was identified in experimental groups of rats (EG1, EG2). A few resorption lacunae were observed in rats simultaneously administered to Se and DZN. Based on these findings we can conclude that subchronic exposure to Se and simultaneous exposure to Se and DZN influences significantly macroscopic and microscopic structure of femoral bone tissue in adult male rats.

**Key words:** femoral bone, macroscopic analysis, histomorphometry, rat, selenium, diazinon



## EFFECTS OF THE DIFFERENT GRAPE ROOTSTOCKS ON ELEMENTS UPTAKE OF THE CSERSZEGI FÚSZERES

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The selection of the most appropriate grape rootstock regarding the production purposes has a positive effect on the grape's, the must's and the wine's quality: it may produce higher vintage quantity and may increase the vintage quality. The grape rootstocks live together with the scion part and they serve each other mutually. The rootstock-scion interaction has outstanding effect on the element uptake of grape. The grape rootstock assortment of the University of Debrecen was planted on immune sand soil in 2003. In 2010 Csereszegi Fűszeres scion was grafted into 14 different grape rootstocks. In 2011 leaf samples were collected from 9 grape rootstocks (*Vitis Berlandieri*, *Berlandieri x Riparia S.O.4*, *Berlandieri x Riparia T.G. 5.A.5.*, *Berlandieri x Riparia T.8.B.*, *Berlandieri x Riparia T.K. 5.BB*, *Berlandieri x Riparia K.125 AA*, *Riparia Sauvage*, *Riparia Selecta*, *Riparia Tomentosa*) and from scion grafted into them (from same vine-stock), and from Csereszegi Fűszeres (standing on own root) as a control in the harvesting period. 8 – plant physiological important – elements were analysed (K, Ca, Mg, P, B, Mn, Fe and Zn) from the leaf samples. We found differences between results of element content of the examined different grape rootstocks' and Csereszegi Fűszeres scion's leaf grafted into them in harvesting period. Based on the results of the 2011 year examinations we found the concentrations of the K, Mg, Mn and Zn were higher in the leaves of scion parts than in the leaves of root parts, while the concentrations of the P, Ca, B and Fe were higher in the leaves of root parts than in the leaves of scion parts generally.

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## THE ROLE OF SELENIUM-ENRICHED FOOD SPROUTS WITH RESPECT TO OUR DAILY SELENIUM NEEDS

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Trace mineral selenium is an essential nutrient of fundamental importance to human biology; therefore it is very important to be in our daily diet. Although it is known that selenium content of foods show big variety, the most widely consumed food have low selenium content.

The goal of our work was to study the enrichment of selenium during germination of wheat and pea (*Triticum aestivum* and *Pisum sativum*) because we assumed based on the previous studies that this sprouts are able to take element high in concentration. Sprouting was chosen because it additionally enhances the nutritional value of seeds, for example, by higher vitamin content, a better quality of protein, and some other parameters. We decided to combine this with higher selenium content.

Inductively coupled plasma mass spectrometry (ICP-MS) was used to determine the total element concentration. After determining this, we calculated how many percent of selenium are found in sprouts treated with Se covers our daily need. With regards to our experiments, we concluded that selenium are good for the treatment of sprout because the highest concentration contribute to cover our daily need of selenium needs.

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## THE EFFECT OF DIFFERENT GROWING AREA ON THE CU, MN AND ZN CONTENT OF WINTER WHEAT

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Cereal crops are important source of mineral elements and nutrients for humans. Globally, wheat is cultivated in one of the three largest quantities of cereals. In this study the Cu, Mn and Zn content of winter wheat grains were investigated. Plant samples were collected from 2005 which was very wet. Samples were harvested from five experimental stations of the Hungarian national long-term fertilization trials. These are the following: Bicsérd, Iregszemcse, Karcag, Nagyhörcsök and Putnok. These experimental fields have different soil types and climatic conditions. The element content of samples were measured using inductively coupled plasma optical emission spectrometer (ICP-OES) and inductively coupled mass spectrometer (ICP-MS) following digestion with HNO<sub>3</sub>-H<sub>2</sub>O<sub>2</sub> solution. Data analysis was performed using SPSS for Windows 13.0 Software package. All data were subjected to ANOVA, and when significant differences ( $P < 0,05$ ) were detected, Duncan's test was performed to allow separation of means. The test results proved that the different regions caused significant ( $P < 0.01$ ) difference in the element content of winter wheat samples. During our investigation the measured results were compared with the literature data. The match was found in the case of copper and zinc contents, but the manganese content was lower in the tested samples.

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## OIL SEEDS AS SOURCES OF SELENIUM

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Selenium is an essential trace element, which has beneficial health effects in humans at adequate concentration, about 60 µg/day. Besides its antioxidant function selenium incorporated in seleno-amino acids, selenomethionine and selenocysteine and these amino acids supports anti-cancer and anti-aging effects. However ensuring the sufficient intake of this element may be limited in some countries, such as Hungary, owing to the soil, which suffers lack of selenium.

In some literature it has been reported, that oil seeds contain higher level of selenium and by this way they are potential selenium sources. Our research aimed to study this opinion and tried to survey the role of these seeds in selenium intake into a human body. It has been pointed out that consuming these foods can moderate but not eliminate inadequate selenium intake, except Brazil nut (*Bertholletia excelsa*) with its high (20 µg/g) selenium-content.

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## TRACE ELEMENT CONTENT OF HUNGARIAN ACACIA HONEYS

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Forty-four acacia honey samples from beekeepers and hypermarkets were examined in our laboratory. Five elements (Al, Cu, Fe, Li, Sr) were analysed by ICP-OES and seven elements (As, Ba, Cd, Cr, Ni, Zn) were determined by ICP-MS. Aluminium, iron and zinc were the most abundant elements in our samples. The concentration ranged between 100.0 and 4910 µg/kg for Fe, 319.0 and 4440 µg/kg for Zn and 242.0 and 3095 µg/kg for Al. The lowest values were  $4.648 \pm 4.184$  µg/kg for Cd,  $27.12 \pm 13.62$  µg/kg for Cr and  $42.49 \pm 20.37$  µg/kg for As. The element concentration increased in the following order: Cd < Cr < As < Li < Ni < Ba < Cu < Sr < Al < Zn < Fe.

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## MICROELEMENTS IN DRUG AND TEAS OF *PLANTAGO LANCEOLATA* L.

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Plantain (*Plantago lanceolata* L.) is a popular medicinal plant for its beneficial effect against respiratory and other antiinflammatory diseases. Since metal ions have significant role in inflammatory processes and antiinflammatory effect, the element content of plantain drug and extracts has been determined.

Element content in drug and different extracts (decoctum and infusum) was measured by inductively plasma optical emission spectrometry (ICP-OES) after nitric acid digestion.

Most of the elements in drug had average concentration, only Al, Cr, Sn, Sr and Ti concentration passed their average level.

Significant difference was found in the concentration of Al, Ba, Ca, Co, Fe, K, Li, Mg, Mn, Na, P, S, Sr and V concentration between decoctum and infusum. In most cases the concentration of elements was about 2-3 times higher in infusum samples than that of in decoctum. In conclusion decoctum is a richer source of elements than the other extract.

## EVOLUTION OF BIO-ACTIVE SUBSTANCES IN ASPARAGUS AS AFFECTED BY DIFFERENT HARVEST TIMES

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In the development of illnesses and the preservation of health nutrition has a decisive part both from qualitative and quantitative points.

Asparagus has considerable vitamin-C contents (20-38 mg/100 g) which play an important role in Fe incorporation and folic acid and protein metabolism. The top of the spear contains the highest quantities which decrease towards the base. Asparagus is remarkable for its low Na content and excellent nutrient element composition.

In our trials at the experimental farm Pallag of Debrecen University 3 asparagus varieties (*Cumulus*, *Gijnlim*, *Grolim*) were tested on brown humus sand soil in ridge cultivation. Solids, nutritional fibre, protein, sugar and vitamin-C contents were measured in the white spears at 3 different harvest times (8 May, 24 May, 6 June 2012). Mineral element tests included B, Ca, Cu, Fe, K, Mg, Na, P, S, Zn and sulphate sulphur.

Element	B	Ca	Cu	Fe	K	Mg
mg/kg	0,08±0,10	76,28±6,06	1,05±0,10	5,83±1,56	1420±122	78,49±5,08

Element	Na	Zn	P	S	Sulphate-S
mg/kg	21,66±5,15	3,63±0,23	346,00±11,29	305,56±33,89	238,67±35,84

The ion ratio of the human body can be characterized by  $(Ca^{2+} + Na^{+}) / (Mg^{2+} + K^{+})$  correlation with ~ 1,0 value under optimal conditions but values about 4,0 are often measured. This ratio is very low in vegetables which contributes to equalize the ion balance of the human body.

## SYNTHESIS OF A SELENOCYSTEINE PEPTIDE FOR QUALITY CONTROL PURPOSES

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Selenium speciation lacks sufficient CRM supply. While NRC-SELM-1 selenium enriched yeast reference material is available for selenomethionine validation, for selenocysteine (Sec) only an indirect blood reference material NIST SRM 1950 can be purchased. Therefore, it is justified to synthesize a new reference material that can serve for the validation of the whole quantification method, including sample preparation, derivatization and chromatographic analysis.

The goal of our study was to work out a direct pathway, i.e., starting directly from Sec<sub>2</sub> with the traditional liquid phase peptide synthesis without addressing the usually applied and complex solid phase (SPPS) protocol. Effective solubilization of Sec<sub>2</sub> in dimethylformamide and its pH-controlled access to pentachlorophenol-activated peptides to couple with were of utmost importance to achieve good yield (45%) of synthesis, monitored by HPLC-UV, SEC-ICP-MS and HPLC-ESI-MS techniques. To demonstrate the possible application of the new compound, (Boc-GGFG)-Sec<sub>2</sub>-(Boc-GGFG) ( $m/z$  1173.3,  $[M+H]^+$ ), it was used to compare the effect of the two most addressed sample preparation techniques of selenium speciation, that is, methanesulphonic acid (MSA) based digestion and proteolytic digestion with protease XIV, on the Sec residue. The study revealed that the use of MSA resulted in the decomposition of Sec even after derivatization with iodoacetamide. Moreover, the new protocol offers the possibility to form longer peptides with the only restriction of aligning the Sec residue at the C-terminal.



## **TOXIC ELEMENTS IN THE SEWAGE SLUDGE – SOIL – PLANT CHAIN**

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According to statistical data the amount of sewage sludge does not increase as it was prognosed some years ago. Although this is a positive effect, we have to solve the problem of recycling of the sewage sludge. The appropriate chemical composition of municipal sewage sludge compost is suitable for nutrient supply in the agriculture.

The small-plot experiment with sewage sludge compost was started in the spring of 2003. Three doses of compost (9, 18, 27 t ha<sup>-1</sup>) and a control treatment were used in the experiment. The small-plot experiment was re-treated in the fall of 2006 and 2009. In the composting process some additives such as bentonite, rhyolite and wheat straw were used to improve the quality of the compost. Our purpose was to stabilize or increase the fertility of sandy soil and contribute to the reduction of environmental pollution. In the plot experiment there were three test plants: triticale, maize and pea. These three plants were sown in crop rotation. We examined the concentration of toxic elements (Ni, Zn) in two soil layers, 0-30 and 30-60 cm in 2008-2009 years.

The aim of the experiment was to investigate whether the application of sewage sludge compost cause hazardous accumulation of toxic elements in the soil and plants.

## NEW SELENIUM SOURCE AS POTENTIAL FEED ADDITIVE

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Egg has important role in our daily diet and it is often in the focus of functional food research. Several literature data have revealed its capability to enrich its composition in biologically active substances like polyunsaturated fatty acids or selenium. Therefore, it is a perfect object to study the nutritive effect of a new selenium source.

The present experiment was created to study the effect of an experimental selenium source on certain egg production traits as well as on quality of egg. Bovans Goldline laying hens (n=60) were sorted randomly into four groups. Feed of the control group was a commercial layer diet without selenium supplementation (Se concentration was 0.2 mg/kg feed). Compound feeds of the experimental groups were based on the same diet, but were supplemented with a commercial selenium additive in one group, and with two different concentrations of experimental selenium supply in the two other groups (Se concentration was 0.245 mg/kg feed). Eggs were collected daily in the third week of the experiment. Among other parameters daily egg production, egg size, yolk colour and selenium concentration were measured.

Both selenium sources were sufficient to increase selenium content of eggs, and the effect of experimental one was more efficient than the commercial one. Some changes were found in other analyzed parameters, as well. However, it is worth to mention that no negative effect occurred even in the group of higher dose of selenium supplementation. Therefore, the experimental selenium source might be the first member of a new generation mineral additive.

## **BIOCHAR PROPERTIES FROM DIFFERENT MATERIALS OF PLANT ORIGIN**

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Biochar is a highly porous solid substance, made of different biomass by pyrolysis. Conditions of pyrolysis as well materials used in it can substantially affect biochar properties. Samples with sufficient sorption surface could be used as a soil additive, able to immobilize risk elements in soil. Soil contamination by risk elements is a serious problem needs to be solved. There are available remediation methods, using plants to remove these elements from soil. Biomass produced during remediation has limited application and biochar production could one option. Plants for our experiments were grown on contaminated soil of Příbram area. For the experiment were used meadow grass, wood mixture of poplar and willows twigs and finally maize. Biomass of these plants was used to prepare biochar. There was observed the effect of the type of biomass and the final temperature on specific surface area and yield of biochar. Both temperature and material affected properties of biochar. While the final temperature increased, the specific surface area increased and the yield of biochar decrease. The highest surface area was found at biochar from wood mixture and the lowest one from hay of grass.

## TESTING OF SELENIUM INHIBITION EFFECT ON SELECTED CHARACTERISTICS OF GARDEN PEA

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Phytotoxicity effect of sodium selenite Se(IV) and selenate Se(VI) was followed on selected characteristics of garden pea (*Pisum sativum*), such as germination, growth, chlorophyll production, content of dry material and water in the seedlings. Laboratory experiments were established in the Petri dishes, which were treated with sodium selenate (Na<sub>2</sub>SeO<sub>4</sub>) and sodium selenite pentahydrate (Na<sub>2</sub>SeO<sub>3</sub>·5 H<sub>2</sub>O) on the selenium concentration levels 5.0; 20.0; 100.0; 300.0 and 500.0 mg Se/l. Phytotoxicity was tested by the tests of chronic phytotoxicity and the results obtained were evaluated as IC<sub>50</sub> values (half maximal inhibitory concentration) by probit analysis. Treatment of seedlings with the solutions of Se(IV) and Se(VI) on the concentration levels 5 mg and 20 mg/l resulted in enhanced growth of shoots and roots, especially after application of Se(IV), where the growth exceeded control for about 70 %. The IC<sub>50</sub> value was higher for the growth of shoots as well as for roots after application of Se(VI), what means that the growth inhibition in early growth stages of garden pea can be observed only in the high selenium concentrations (over 200 mg Se/l). Se(IV) showed more significant inhibition of chlorophyll production in the shoots of peas seedlings than Se(VI). Lower concentrations of Se(IV) and Se(VI) (below 100 mg Se/l) did not show significant differences between the water contents, but the higher concentrations (300 mg Se(IV)/l and 500 mg Se(VI)/l) resulted in significant differences, more than 9-times higher in roots.





## NOTES

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