ELECTROANALYTICAL METHODS IN TRACE ELEMENT ANALYSIS OF PLANT MATERIALS

Vlastimil DORČÁK[1], Pavel MADER[1], Nico MAJOR[2], Daniela MIHOLOVÁ[1], Jiřina SZÁKOVÁ[1§], Dana KOLIHOVÁ[1], Heike HEIDENREICH[2], Siegfried KORHAMMER[2], Ivana ŠESTÁKOVÁ[3], Věra VESELÁ[4], Petra ČÍŽKOVÁ[1]

[1] DEPARTMENT OF CHEMISTRY (AGROCHEMISTRY), FACULTY OF AGRONOMY, CZECH UNIVERSITY OF AGRICULTURE

[2] DEPARTMENT OF ENVIRONMENTAL HIGH TECHNOLOGY, IHI ZITTAU, GERMANY

[3] J. HEYROVSKÝ INSTITUTE OF PHYSICAL CHEMISTRY, CAS, PRAGUE 8, CZECH REPUBLIC

[4] INSTITUTE OF EXPERIMENTAL PHYSICS, SAS, KOŠICE, SLOVAKIA

Summary, keywords

Any measuring technique suitable for determination of total contents of chemical elements in biological matrices is suitable for determination of their individual chemical forms, provided that good separation of these forms and matrix decomposition in individual fractions have been performed prior the measurement. Electrochemistry has additional potential in that it can directly respond to a number of organic ligands coordinating metal cations in various complexes.

Plants, heavy metals, speciation, electrochemistry.

Introduction

Electroanalytical techniques are highly sensitive for determination of total contents, and also chemical forms, of chemical elements. At the same time, they are also often very demanding as concerns the sample preparation step (Mader et al., 1996). In Part I we have compared 4 decomposition methods and 4 measuring techniques in determination of total contents of Cd, Cu, Pb and Zn in 2 plant materials. Part II deals with problematic of chemical speciation of Cd in plants and possibilities of application of electrochemistry in its study.

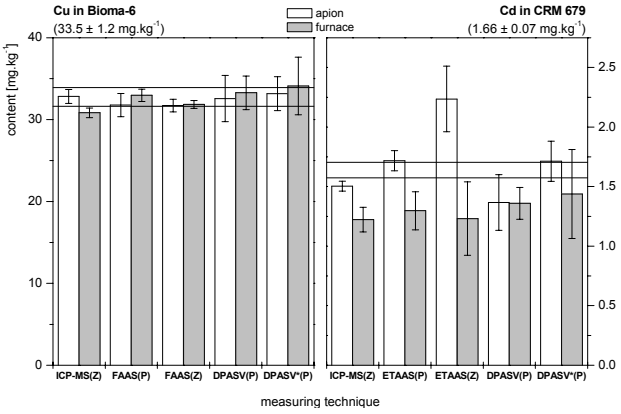
Methods

Part I. CRM 679 *Brassica oleracea* and candidate RM Bioma-6 *Chlorella vulgaris* were two plant materials used. Classical dry ashing, dry ashing in mineralizer Apion, microwave assisted wet digestion and wet digestion in High Pressure Asher were used for their decomposition. Differential pulse anodic stripping voltammetry (DPASV), flame and flameless atomic absorption spectrometry (FAAS, ETAAS), inductively coupled plasma optical emission spectrometry (ICP-OES) and inductively coupled plasma mass spectrometry (ICP-MS) were applied for measurement in Prague (P) and Zittau (Z).

Part II. Peptides Cys-Gly, γ-Glu-Cys and reduced glutathione were commercial products, phytochelatins PC_2 and PC_3 were prepared synthetically. DC polarography was carried out using polarograph PA4 with recorder Endim 622.01. The 3-electrode system consisted of dropping mercury electrode, saturated calomel electrode and platinum counter electrode. DC and DP voltammetric measurements were carried out using the Eco-Tribo Polarograph (Polaro–Sensors, Czech Rep.) with hanging mercury drop electrode, Ag/AgCl and Pt as auxiliary electrode. For deaerating the solutions, argon or nitrogen was used.

Results - discussion

Part I. Examples given in the enclosed Figure illustrate that stripping voltammetry yields at least as good results as the other measuring methods tested. In the DPASV* measurement, digest originally prepared for AAS had to be modified by increase of pH; then, DPASV yielded again very good result. Overall evaluation, based e.g. on the Z-score, will be presented in the poster.



Part II. Phytochelatins help plants to cope with the Cd(II) stress by forming complexes with cysteine residues. Their SH-groups are at the same time highly polarographically active. This activity is further enhanced in the presence of cobalt(II) ions and the so-called Brdička catalytic hydrogen currents are then produced. The latter currents are used on empirical basis for quantitation of phytochelatins (see e.g. Olafson and Olsson, 1991). We have performed detailed study with classical polarography and direct current and differential pulse voltammetry, using our previous experience with Brdička currents (see Mader et al., 1982 and literature quoted there). Results of this study and conclusions based on them form the second part of our poster.

References

Mader P., Kolthoff I.M., Veselá V.: Electrochimica Acta 27 (10): 1393-1401, 1982.

Mader P., Száková J., Čurdová E.: Talanta 43: 521-534, 1996.

Olafson R.W.,Olsson P.-E., in: Methods in Enzymology, Vol. 205 (Eds. Riordan J.F., Vallee B.L.), Acad. Press, New York 1991, 205-213.

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