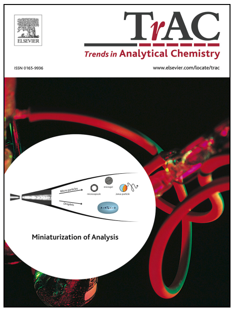
Accepted Manuscript



Advances in mass spectrometry for iron speciation in plants

Ghaya Choubassi, Justyna Aszyk, Paulina Pisarek, Katarzyna Bierla, Laurent Ouerdane, Joanna Szpunar, Ryszard Lobinski

PII: S0165-9936(17)30231-5

DOI: 10.1016/j.trac.2017.11.006

Reference: TRAC 15047

To appear in: *Trends in Analytical Chemistry*

Received Date: 27 June 2017

Revised Date: 5 November 2017

Accepted Date: 6 November 2017

Advances in mass spectrometry for iron speciation in plants

Ghaya Choubassi[a], Justyna Aszyk[a,b], Paulina Pisarek[a,c], Katarzyna Bierla[a], Laurent Ouerdane[a], Joanna Szpunar[a] and Ryszard Lobinski[a,c]

[a]*Institute of Analytical Sciences, IPREM, UMR 5254 CNRS-UPPA, Hélioparc, Pau, France*

[b]*Department of Analytical Chemistry, Faculty of Chemistry, Gdansk University of Technology, 11/12 Narutowicza Str, Gdańsk, Poland*

[c]*Department of Analytical Chemistry, Warsaw University of Technology, Noakowskiego 3, 00-664 Warsaw, Poland*

Abstract

Iron is an important nutrient essential for plants and critical for human health. The state-of-the art of methods for iron speciation in cereal grains and plant fluids is critically reviewed. Particular attention is given to the latest developments in the coupling of HPLC with the parallel ICP MS and electrospray ionization (ESI) MS/MS detection, usually QTOF MS or Q-Orbitrap MS, for the identification and quantification of iron species. The coupled techniques allow the direct microanalysis of plant intracellular fluids (xylem and phloem) and complement X-ray absorption spectroscopy (XANES and EXAFS). The increasing resolution and sensitivity of electrospray mass spectrometers and emergence of software allowing extraction of iron specific data from large chromatographic data sets are responsible for the growing role of electrospray MS/MS in speciation studies. The use of stable isotopes for the probing of the reactivity and stability of endogenous metal complexes and quantitative analysis are rising in importance.

1. Introduction

Iron deficiency anemia which is a consequence of inadequate dietary intake and low bioavailability of iron affects ca. 30% of the world's population [1]. It produces serious adverse health effects with socioeconomic implications and combating it has been considered as one of the 10 major challenges faced by the mankind [1]. The core of the problem is the unfavorable iron speciation: relatively low levels of non-heme iron and high levels of dietary factors, such as e.g. phytic acid which inhibit human iron absorption in stable food crops [2].

The challenges driving research in iron speciation in plants include the understanding of the mechanisms governing the uptake of iron from soil, its transport to aboveground plant tissues and storage, and of the mechanisms of the bioavailability of Fe from staple food, such as wheat, beans, barley, or maize in [3, 4]. The iron concentrations reported in studies of edible grains varied between 15 and 115 µg/g [3-7]. Higher plants have developed two distinct strategies to acquire iron, which is only slightly soluble in soil, from the rhizosphere: (i) the reduction strategy where Fe(III) is reduced to Fe(II) which can then be transported into the root epidermal cells by the divalent metal transporters and (ii) the chelation strategy where Fe(III) is complexed by soluble phytosiderophores (PS) induced upon iron deficiency and released from the root epidermis, the resulting Fe (III)-PS complexes are readily transported back into the roots [8, 9]. Coumarins were recently discovered to play an important role in Fe acquisition from soil for plants [10,11]. However, the actual formation of a Fe-