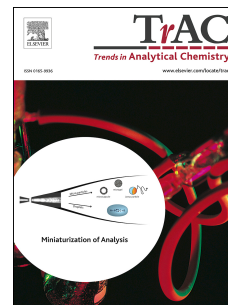


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Advances in mass spectrometry for iron speciation in plants

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# 1 Advances in mass spectrometry for iron speciation in plants

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9

## 10 Abstract

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

22

## 23 1. Introduction

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

30 The challenges driving research in iron speciation in plants include the understanding of the  
31 mechanisms governing the uptake of iron from soil, its transport to aboveground plant tissues and  
32 storage, and of the mechanisms of the bioavailability of Fe from staple food, such as wheat, beans,  
33 barley, or maize in [3, 4]. The iron concentrations reported in studies of edible grains varied between  
34 15 and 115 µg/g [3-7]. Higher plants have developed two distinct strategies to acquire iron, which is  
35 only slightly soluble in soil, from the rhizosphere: (i) the reduction strategy where Fe(III) is reduced to  
36 Fe(II) which can then be transported into the root epidermal cells by the divalent metal transporters  
37 and (ii) the chelation strategy where Fe(III) is complexed by soluble phytosiderophores (PS) induced  
38 upon iron deficiency and released from the root epidermis, the resulting Fe (III)-PS complexes are  
39 readily transported back into the roots [8, 9]. Coumarins were recently discovered to play an  
40 important role in Fe acquisition from soil for plants [10,11]. However, the actual formation of a Fe-

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