Iron uptake and distribution in sugar beet plants treated with *racemic* and *meso* Fe(III)-*o,o*EDDHA isomers

Irene Orera[a], José Ángel Rodríguez-Castrillón[b], José Ignacio García Alonso[b], Mariella Moldovan[b], Javier Abadía[a], Anunciación Abadía[a], Ana Álvarez-Fernández[a]

[a]*Department of Plant Nutrition, Estación Experimental de Aula Dei (CSIC), PO Box 202, E-50080 Zaragoza, Spain,*
[b]*Department of Physical and Analytical Chemistry, University of Oviedo, 33006 Oviedo, Spain.*

Abstract

The synthetic ferric chelate based on the molecule ethylenediamine-N,N'-bis(hydroxyphenylacetic)acid, commonly named as Fe(III)-*o,o*EDDHA, is one of the most efficient fertilizers used to correct Fe deficiency in crops growing in calcareous soils. Iron(III)-*o,o*EDDHA has two diastereoisomers, the *meso* form and the *racemic* mixture, which are present in approximately equal amounts in commercial Fe-chelate fertilizer formulations. In previous studies, evidence was presented that Strategy I plants (tomato, pepper [1], bean [2, 3] and cucumber [4]) take up Fe preferentially from the *meso* chelate form when compared to the *racemic* one. The aim of the present work was to determine the differences in Fe uptake and distribution inside the plant between both Fe(III)-*o,o*EDDHA isomers, using the Strategy I species sugar beet, stable Fe isotopes (^{54}Fe and ^{57}Fe) and inductively coupled plasma-mass spectrometry (ICP-MS). Both Fe(III)-*o,o*EDDHA isomers were separated by selective Mg precipitation, then Fe was removed and the resulting *o,o*EDDHA acid isomers were chelated with ^{54}Fe or ^{57}Fe. Iron-deficient sugar beet plants were treated for 24 hours with i) 30 μM *racemic* ^{57}Fe(III)-*o,o*EDDHA : 30 μM *meso* ^{54}Fe(III)-*o,o*EDDHA or ii) 30 μM *racemic* ^{54}Fe(III)-*o,o*EDDHA : 30 μM *meso* ^{57}Fe(III)-*o,o*EDDHA. Roots, xylem sap, old and young leaves were sampled, and the ^{56}Fe, ^{54}Fe and ^{57}Fe contents in all plant materials and nutrient solutions were determined by isotope dilution analysis and ICP-MS. Plants took up Fe preferentially from the *meso* Fe(III)-*o,o*EDDHA isomer, independently of the Fe stable isotope used. However, the distribution of the Fe supplied by both isomers inside the plant was different, since the Fe isotope supplied by the *meso* isomer accumulated preferentially in roots, whereas plant shoot materials (xylem and leaves) had similar contents of the Fe isotopes provided by both isomers. Therefore, it can be concluded that both isomers were equally effective in allocating Fe in aerial plant parts, whereas the *meso* isomer was more effective in allocating Fe in roots.

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