

## 锌在超积累植物东南景天叶片细胞水平的吸收积累特征

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### Uptake kinetics of zinc in hyper-accumulating species of *Sedum alfredii* Hance at the leaf cellular level

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**摘要** 利用同位素示踪技术研究锌在两种生态型东南景天叶片及叶片原生质体的吸收积累特征。结果表明, 锌在东南景天叶片及叶片原生质体中的积累过程分为开始的快速吸收和随后的缓慢吸收两个阶段, 超积累生态型东南景天吸收的<sup>65</sup>Zn明显高于非超积累生态型。两种生态型东南景天叶片及叶片原生质体吸收锌的浓度动力学均为平滑的非饱和曲线, 可分为饱和部分和直线部分, 其中饱和部分可以用Michaelis-Menten方程拟合。两种生态型东南景天的米氏常数( $K_m$ )差异不显著, 而超积累生态型的最大吸收速率( $V_{max}$ )显著高于非超积累生态型。代谢抑制剂(CCCP)处理显著抑制了超积累生态型东南景天叶片原生质体对锌的吸收。研究表明, 在超积累生态型东南景天叶片细胞膜上存在锌载体调控体系, 能够促进跨叶细胞膜运输并储藏到液泡中, 降低对细胞的毒害, 是东南景天超积累锌的重要机制之一。

**关键词:** 东南景天 原生质体 吸收 锌 东南景天 原生质体 吸收 锌**Abstract:**

Vacuolar compartmentalization in leaves could play a major role in hyper-accumulation of heavy metals. However, little is known about the physiology of intracellular zinc (Zn) sequestration in plants. Radiotracer techniques were employed to characterize <sup>65</sup>Zn uptake kinetics in leaf sections and leaf protoplasts of hyper-accumulating ecotype (HE) and non-hyper-accumulating ecotype (NHE) species of *Sedum alfredii* Hance. The time-dependent kinetics of <sup>65</sup>Zn uptake in leaf of *S. alfredii* Hance consisted of two stages with an initial rapid stage followed by a longer but slower stage. Zn accumulation in leaf sections and leaf protoplasts of the HE was much higher than that of the NHE. Concentration-dependent kinetics of <sup>65</sup>Zn uptake in leaf sections and leaf protoplasts of *S. alfredii* Hance yielded non-saturating kinetic curves that could be divided into linear and saturable components. This saturable component could be characterized by Michaelis-Menten equation, and there were no significant differences in the calculated  $K_m$  between the two ecotypes, whereas  $V_{max}$  values for HE were much higher than for NHE. Carbonyl cyanide-m-chlorophenylhydrazone (CCCP) treatment strongly inhibited <sup>65</sup>Zn transport into protoplasts, especially in HE, indicating that we were measuring primarily true transmembrane Zn that was transported into *S. alfredii* Hance. These findings indicate that there was a carrier-mediated system in plasma membrane which could effectively move cytoplasmic Zn into the vacuole, and this carrier-mediated system play a role in the dramatic Zn hyper-accumulation expressed in *Sedum alfredii* Hance.

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