

Silicon Plays a Key Role in Rare Earth Elements Detoxification in a Hyperaccumulator Fern

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The fern *Dicranopteris linearis* (Gleicheniaceae) is a hyperaccumulator of Rare Earth Elements (REEs), aluminium (Al) and silicon (Si). However, the physiological mechanisms to the excess of REEs and Al, and possible interactions with Si, are currently incompletely known. In the present study, Synchrotron Radiation-based X-ray Fluorescence (XRF), Proton Induced X-ray Fluorescence Spectrometry (PIXE), Scanning Electron Microscopy-Energy Spectroscopy (SEM-EDS) and a series of chemical extraction experiments were conducted to decipher the localisation and biochemistry of REEs, Al and Si in *D. linearis*. The results show that all the REEs (e.g., La, Ce, Pr, Nd and Y) are mainly co-localised with Mn and Si in the necrotic lesions and the epidermis of the pinnae. The extraction patterns of REEs, Al and Si in *D. linearis* pinnae indicate an existence of REEs and Al silicates. Furthermore, phytolith (Si oxides) and phytolith Al are found at the epidermis of pinnae and the pericycle of veins by SEM-EDS observations. Therefore, co-precipitation with Si is possibly responsible for the detoxification of the high concentrations of REEs and Al in *D. linearis* pinnae. In conclusion, we posit that Si plays a critical role in REEs and Al detoxification within the blade. The results presented here provide insights in how plant regulates high concentrations of REEs *in vivo*, and this knowledge is useful for developing phytotechnological applications (such as REE agromining) using this fern in REE-contaminated sites in China.