A three-dimensional perspective on multiple biomineralization in Loasaceae trichomes

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April 28, 2020

Abstract

This work presents new findings about the spatial arrangement of up to three biominerals in plant trichomes. Many plants develop hard, mineralized structures primarily as a defence against herbivores. Stinging hairs and other trichomes particularly of Loasaceae show the most complex mineralization patterns in any living organism in the form of single-celled structures with the three biominerals calcium phosphate, calcium carbonate, and silica. Scanning electron microscopy with high-resolution EDX element analyses of sample surfaces and sections provides a three-dimensional view of the extreme chemical heterogeneity of cell walls. All three biominerals occur in two different contexts: either as nearly pure mineral structures, e.g., on surfaces and in hooks, or as composite materials with a higher proportion of carbohydrates (cellulose, pectin), especially in the bulk of the cell wall. Raman spectroscopy permits the identification of both organic and inorganic compounds side by side. The chemical composition of cell walls may change abruptly, or gradually across cell walls; the cell lumen may be additionally filled with amorphous minerals. Water-solubility of the different mineral fractions is remarkably divergent. Overall, we here demonstrate that different mineral and organic components permit plants to fine-tune the mechanical properties of cells and tissues.

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